SAE Journal

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Lancaster, Pa.

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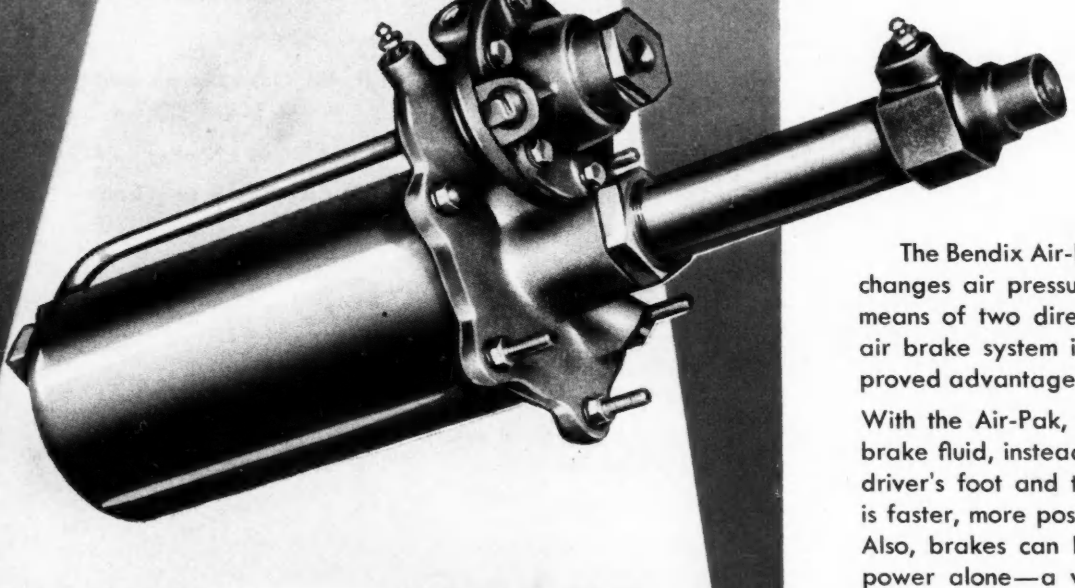
Bendix AIR-PAK

An Air Brake System that Revolutionizes Heavy Vehicle Braking!



The Bendix Air-Pak is an air-hydraulic unit that changes air pressure into hydraulic pressure by means of two direct connected pistons. Thus an air brake system is combined with all the well-proved advantages of hydraulic brake actuation.

With the Air-Pak, a non-compressible column of brake fluid, instead of air, connects between the driver's foot and the brake shoes. Brake action is faster, more positive and under better control. Also, brakes can be applied instantly by foot-power alone—a valuable emergency stand-by if brakes are needed before air pressure builds up, or if air pressure fails for any reason.

The Air-Pak is similar in design and principle to the well known Bendix* Hydrovac*, vacuum-hydraulic braking unit, in use today on more commercial vehicles than any other power braking system. Bendix has built more than 2½ million Hydrovacs; thus the Air-Pak has a matchless background of related engineering and manufacturing experience.

A descriptive folder on Air-Pak will be sent on request.

*REG. U. S. PAT. OFF.

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BRAKING HEADQUARTERS FOR THE AUTOMOTIVE INDUSTRY

Stamped Torque Converter Breeds Production Problems

BASED ON PAPER* BY

H. O. Flynn, Resident Engineer, Chevrolet-Cleveland, Chevrolet Motor Division, General Motors Corp.

* Paper "Problems Involved in Joining Sheet Metal for Torque Converters," was presented at SAE Annual Meeting, Detroit, Jan. 11, 1951.

METHODS of manufacturing the torque converter for Chevrolet's automatic transmission grew mainly from a process of elimination. Forming, brazing, machining, balancing, and checking vane angles of stamped steel converter parts were replete with challenges.

Choice of material for the vaned members narrowed down to three—cast iron, aluminum, and sheet steel. Fabricating methods tried and abandoned with each are shown in the panel on pages 20-21. Some of these just didn't produce the desired results. Others looked as if they would take too long to make practical.

We finally settled on sheet steel stampings joined by copper brazing. The brazing mixture consists of a 500-mesh copper powder mixed with a fluid. Two mixture ratios are used. The "heavy" mix has a viscosity of 15 sec and takes 5½ to 6 lb. copper per gal of fluid vehicle. The "light" mix has a viscosity of 13½ sec, and takes 4½ to 5 lb. copper per gal of fluid.

Brazing troubles were the second tough nut to crack. At first converter parts moved into the brazing furnace at conveyor belt speed. This was bad because the part moved slowly into the heat range. The forward end expanded rapidly while the rear end still was cool. This made the member egg-shaped, as much as 11/16 in. out-of-round in some cases.

We overcame this, but ran into other problems. The parts were rapidly pushed into the heat zone; after coming to heat, they were quickly pushed out to cool. Aim was to keep heating and cooling rates uniform. But this produced a "wet straw hat" effect. The parts lacked strength and stiffness at 2060 F, when steel is plastic.

The primary pump assembly also was a brazing headache. The unit consisted of 29 vanes, an inner shell, outer shell, and a heavy gage housing, all brazed into a complete assembly. This heavy unit needed too long a time cycle in the furnace. First the assembly was brazed open face up; but copper ran down and remained at the lowest level. It blocked part of the fluid passageway cross-section. Turning the open face down wasn't good either. Weight of the heavy housing deformed the light-gage inner members at brazing temperature.

Holding fixtures had to be reinforced; they too warped. Lack of gas circulation was the most serious obstacle. It was due to the pump housing rim extending so far above the vane section. Gas purging or cleansing is a must in brazing converter units to remove any oxygen or oil vapor.

Next decision was to weld the vanes only to hold them in position to the inner shell, snap the outer shell in place, then to braze this unit. After brazing, the vaned structure was spot welded to the heavy gage pump outer housing.

At this time 20 cars were operating at the proving grounds and cross country. They had converters with brazed pumps and turbines. A retarding overrun coupling was included within the torus core. Stators and secondary pumps were spot welded only. Two secondary pumps suffered weld failures in rapid succession. Brazing was then declared essential for small members too.

The basic design now had evolved into a pattern. Production equipment was needed to give consistently accurate units totaling hundreds of thousands. This called for 120 major dies, supplemented by 100 assembly process fixtures. Multistaged progressive dies were included, all built to hold unusually close limits. More than 200 special gages were needed. The job also involves some 125 major pieces of equipment such as presses.

Two methods are used in manufacturing the five main converter members. (These units are shown in Fig. 1.) The primary pump and turbine are pro-

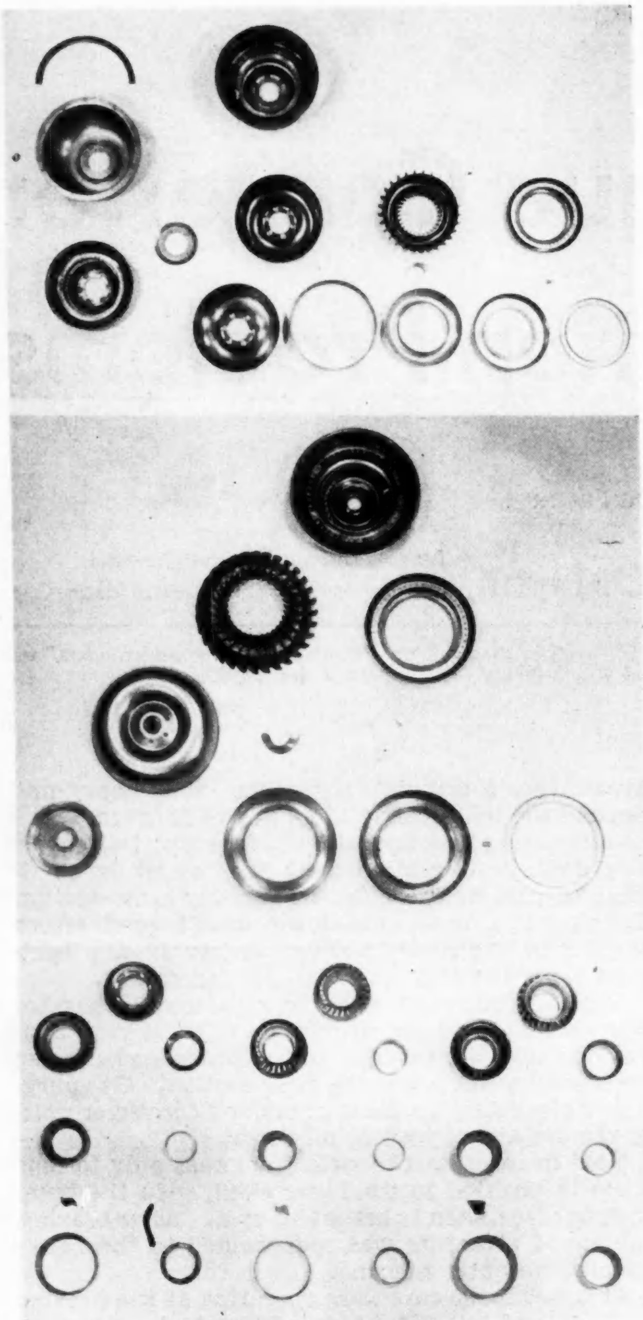


Fig. 1—Current production units for torque converter of Chevrolet automatic transmission. At the top is the primary pump and its components; center, the turbine; and bottom, stators and secondary pump assembly and components

duced by one fabricating sequence; the two stators and secondary pump by the other.

Procedure for the 83-piece primary pump is as follows:

The pump inner shell is placed with the concave side down on a fixture. See Fig. 2. The 29 pump vanes are hand-placed in position. A slotted locator for the vane ends gives correct vane angle. A spot weld fastens the vane flange to its shell in three places. The unit is rigid enough to hold alignment without a fixture.

Meanwhile, a separate subassembly has been prepared consisting of the over-run coupling. Here is what it consists of: The over-run coupling vanes are assembled automatically into the over-run vane supporting shell and the ends are upset. The coupling shroud is pressed over the open end of the vanes and its flanges upset. These parts are carried by conveyers to the dipping tanks and final assembly operations.

The inner shell and vane assembly is dipped into the heavy mix, allowed to drain, and assembled with a snap fit into the outer shell. The heavy mix is brushed on the outer shell surface, which later will contact the over-run coupling section. The over-run coupling subassembly is dipped into the light mix to a depth of ½ in. and turned upside down to drain.

The over-run coupling assembly (made up of 45 half-moon blades between a shell and U-shaped retainer) next is placed into the primary pump assembly. The assembly then is turned over and the primary pump outer shell is placed in position. A copper brazing ring is placed at the junction of hub and outer shell to provide copper for the subsequent brazing operation.

Next the assembly is sent through the brazing furnace mounted on a silicon carbide fixture. Primary pumps are sized after cooling to correct any slight out-of-roundness due to brazing temperature.

After sizing, the solidified copper which collects in the vane ends is removed by an abrasive wheel down to the true vane edge. This operation is important because it provides a reference for all later machining. This locating plane is established by a ring placed in contact with exit ends of the pump vanes; the ring must not rock over 0.005 in. The now-completed vane structure is welded in the pump housing at rim and center.

Manufacturing sequence for turbine and primary pump are exactly the same, except no turbine outer housing is required.

Third main member, the wide stator, is a welded and brazed vaned structure consisting of 27 pieces. Here is how these parts are built up: The outer shell is installed in the fixture, the vanes assembled, and inner shell inserted. The outer shell is welded in one spot and inner shell in two. A subassembly of the over-run cam sleeve and inner ring, previously welded together, then is welded to the subassembly of inner and outer shells and vanes.

Next the wide stator is dipped in the heavy mix. It is allowed to drain in three positions—on one end, on its side, and then on the opposite end.

The narrow stator is assembled exactly the same way. It is similar to the wide stator, but has more pieces. Same procedure is followed for the secondary pump. It has 36 pieces. The five units contain a total of 257 pieces.

Two brazing furnaces, shown in Fig. 3, are used. Each is 184 ft long, and has a capacity of 5000 lb per hr. The furnaces have an endothermic atmosphere in conjunction with Glo-Bar heaters. This particular brazing condition calls for an abnormally high gas flow of 4000 cu ft per hr. Dew point is maintained at 65.

Converter machining operations were not without problems. Experimental parts were machined on all inner and outer shells and vane ends. This gave the tool room no headaches. But speeds and feeds

comparable to proposed production practices unleashed a Pandora's box of woe.

Converter parts are made of SAE 1008 or 1010 rimmed steel. Exposure to 2060 F brazing temperature leaves them dead soft. Cutting tools removed the metal in strings many feet long. The strings formed balls, which tore or deformed the vanes and left sizable burrs. No practical way could be found to remove the burrs. Machining on the vane ends was eliminated by maintaining vane location accuracy in brazing assembly.

Tighter stamping and brazing control eased machining headaches by eliminating two kinds of operations—machining of metal surfaces and metal removal forming great balls of cuttings. Carbide tools are used exclusively on all finish operations at surface speeds of 700 to 1600 fpm. Roughing cuts with 100 to 400 fpm surface speed are made with cast alloys. Plunge cuts are used where possible to hold down the burr problem. On cross-feed cuts, cutting tool dullness tends to spin rather than shear the metal.

The main pump and turbine need large equipment. One big problem here was to develop chucks that would securely hold the part without crushing or deforming it. The chucks also have to locate the part's true center to minimize runout.

First operation on the primary pump is done on an eight-spindle Bullard "Mult-Au-Matic," shown in Fig. 4. The part is placed in a chuck at the loading station. Then a vertical locating ram positions the part correctly by a ring which contacts the vane ends. Next the chuck jaws are tightened. One of the surfaces machined in the first operation is used as a locating face for subsequent machining.

The turbine is handled like the primary pump. The two stators and secondary pump are initially located from the vane ends and outside diameter for the first operation. All succeeding operations are conventional. Inside diameter is precision bored and graded for size. The over-run cams (freewheelers) have also been graded for size. The vaned members are heated to 300 F and the cams cooled to 40 F. The two parts then are assembled to an average of 0.0002 in. press if parts were at room temperature. The inner sleevs are staked into eight notches in the over-run cam. Over-run cams are thin in section. They become distorted if assembled with a heavy press fit.

All balancing, done on GM Research vertical equipment, is actually a 600 rpm rotating balance check. The primary pump assembly with its cover and turbine assembly are balanced to a maximum of 1/4 in.-oz. They average less than 1/8 in.-oz.

All five parts were balanced during initial development. But the three small members were found to be within 1/4 in.-oz, so they are not balanced in production.

For balancing, the turbine is assembled to its hub with full complement of thrust washers and turbine pilot. The turbine assembly is dry balanced by projection welding counterweights. These are placed on a point on the outer shell where weight does not add to dynamic unbalance.

The primary pump and cover assembly are balanced full of oil. Experiments showed that "hydraulic balance" and "dry balance" are not the

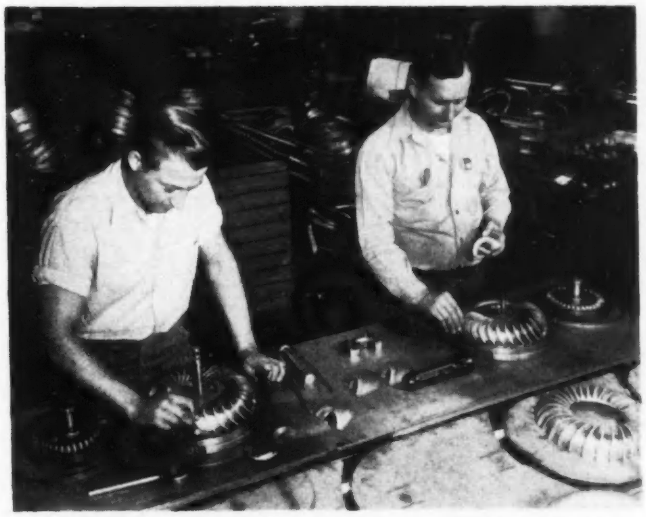


Fig. 2—Primary pump and turbine vanes are assembled manually

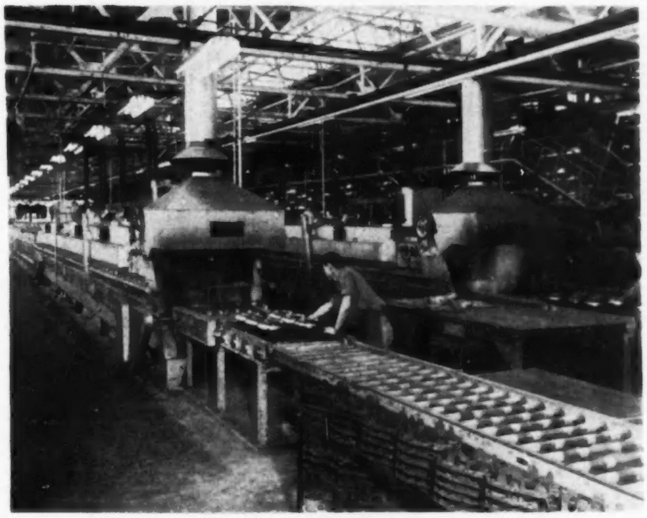


Fig. 3—Converter units are brazed in these 184-ft long furnaces

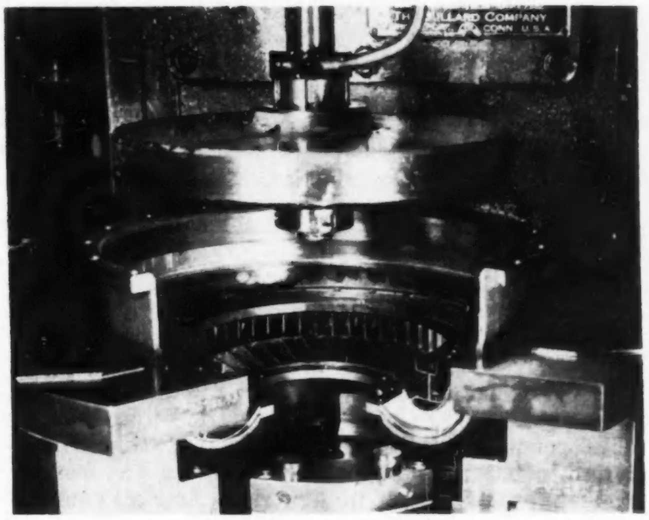
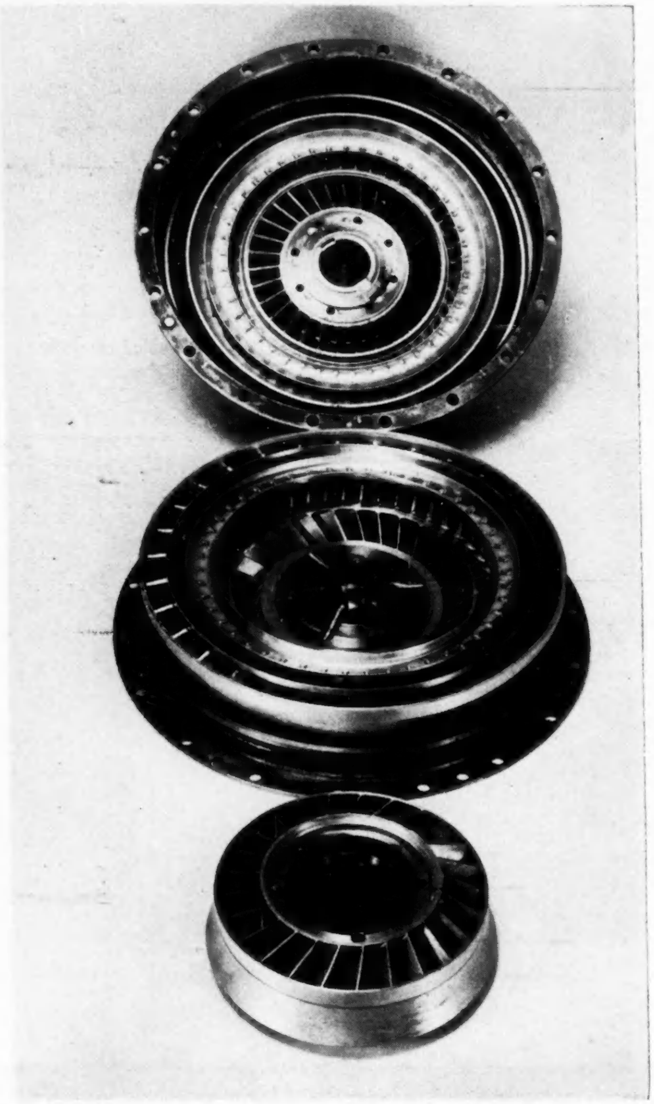


Fig. 4—Chucking for primary pump, machined on a Bullard "Mult-Au-Matic," is designed to prevent distortion of the part

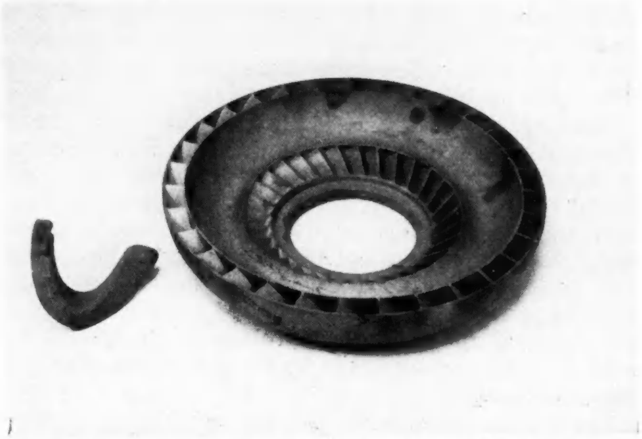
Converter Constructions

Cast Aluminum



Aluminum members proved efficient and easy to machine. These parts were made by the Antioch process. Using plaster for cores overcame core-setting difficulties. But aluminum was abandoned because sheet metal construction looked better for large production.

Cast Iron



Cast iron was the first material tried. This thin-walled grey iron turbine was cast. Core is at left. High pouring temperatures and sand cores caused troubles. Loose sand particles prevented correct vane location.

Tabbed Vane Stampings

First experimental sheet steel converters had vanes with tabs on each end. Tabs fitted into sawed slots in inner and outer shells. Vanes were copper plated and brazed. Objections: punches for slot-cutting would be short lived and slotting with cutters undesirable.

same. The difference stems from any runout between pump housing inside diameter and part centerline.

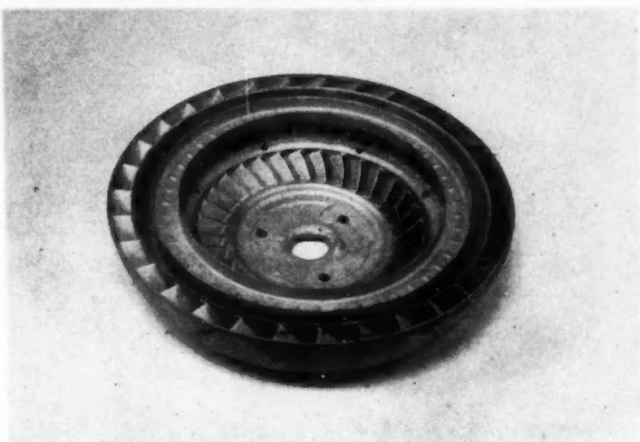
In early development, some units that balanced perfectly on the rotating static machine operated too roughly in the car. Drilling the pump housing reinforcement rings only aggravated the original dynamic balance. A point 2⅜ in. to the rear of this ring was found to be neutral. Now all counterweights are projection welded at this point. A periodic dynamic balance inspection rechecks the rotating static balancing machine.

Two points were constantly debated in the early experimental program. Did the vanes have the correct contour? Were the vanes properly placed in the finished part? First three methods tried didn't give satisfactory answers; the fourth did.

First units were checked with conventional equipment for surface plate work. Second step was to convert a Helical Gear Lead Comparator so that a metal master and an actual part could be placed side-by-side in a fixture. A stylus then explored

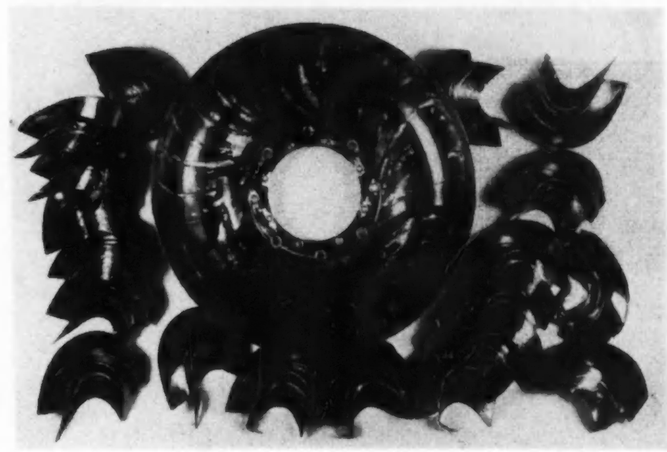
that Didn't Work

Aluminum Dipping



A bond between vane flanges and shells, plus welding, was tried. Some units were dipped in a salt bath, then in molten aluminum. But spinning to remove excess aluminum also removed material at vane and outer shell junction.

Phenolic Resin Cementing



A shell was positioned in a heating die, phenolic tape put in place, vanes positioned, die closed, and temperature raised to 400 F. After cooling, the turbine seemed to be firmly bonded. But it broke into pieces when tested.

Shingle Construction

Thirty-one turbine vanes with small flanges were joined by over-lapping the flanges and spotwelding each vane to its neighbor by four welds. Contours were not true nor smooth, weldments lacked strength, and flimsy gooseneck electrode was impractical.

Continuous Outer Shell

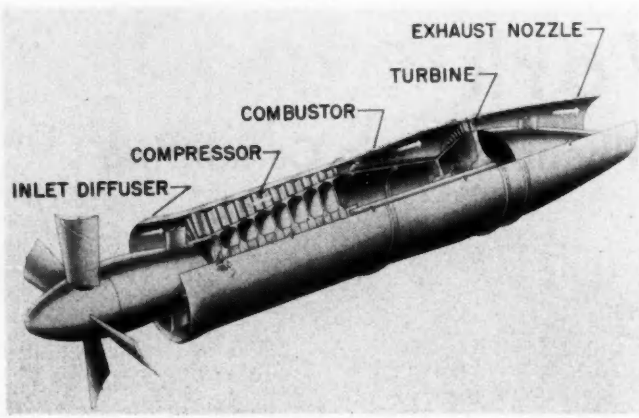
Shingle construction was modified by welding vanes to an outer shell to reduce abrupt step in outer surface. But when spun at high speed, the unit failed. Parent metal surrounding the spot welds on the vanes broke away from the outer shell.

the surface of the master and a matched stylus read the departure of the part from the master. Each stylus had to start exactly at the vane edges. But the method was discarded because it didn't work well in practice.

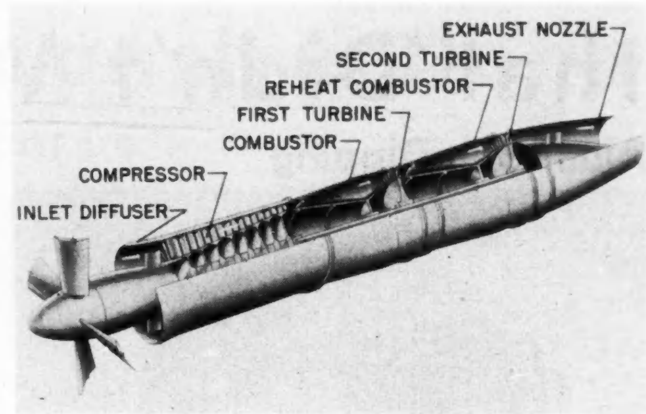
Third method, for checking the two stators and secondary pump, used a Fellows Gear Lead Checker by modifying the sine bar setting. This rolled out a section in a helical path. But the section developed was useless because no one could make sense of the values obtained.

The current method uses a profile exploring stylus directly connected to a pantograph. The pantograph transfers the stylus motion to a target point located in the light beam of a comparator and magnifies it optically. This produces an accurate profile with "x" and "y" ordinates that can be compared readily with similar sections.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)



1. **Basic turboprop engine**



2. **Reheat turboprop engine**

Four Turboprop

EXCERPTS FROM PAPER* BY

Tibor F. Nagey, Aeronautical Research Scientist, Lewis Flight Propulsion Laboratory, NACA

* Paper "Comparison of Turbine-Propeller Engines with Various Cycle Arrangements for Subsonic Flight Speeds," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 29, 1950.

AN analysis made at the NACA Lewis Laboratory showed that aircraft performance gains are possible by applying reheat, regeneration, and a combination of the two to a turboprop engine.

Engine configurations investigated are shown above. Simplest of the engines is the basic turboprop. The engine consists of an inlet diffuser, compressor, combustor, turbine, and exhaust nozzle.

The reheat engine has essentially the same operating cycle as the basic engine, with one exception. Expansion occurs in two turbines with additional fuel burned between the turbines to increase total turbine work.

The regenerative engine deviates from the basic engine by having the exhaust gases from the turbine directed through a regenerator. Here the air leaving the compressor is heated before the addition of fuel in the combustion chamber. This reduces the amount of fuel required to attain the desired turbine-inlet temperature.

The regenerative-plus-reheat turboprop engine combines a regenerative engine and a reheat engine.

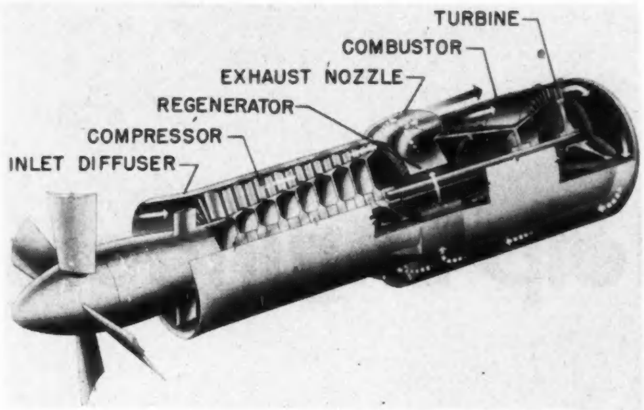
The analysis covered an overall rage of flight speeds from 200 to 600 mph, altitudes from sea level to 50,000 ft, and turbine inlet temperatures from 2000 to 2500 R for a range of compressor pressure ratios of 6 to 42.

Comparison was made of the minimum specific fuel consumption of the regenerative-plus-reheat turboprop engine with the simpler turboprop engines. It showed that at sea level, the combination of regeneration and reheat gave a decrease in minimum specific fuel consumption of approximately 2% from that of the reheat engine, 6% from that of the regenerative engine, and 10% from that of the basic engine.

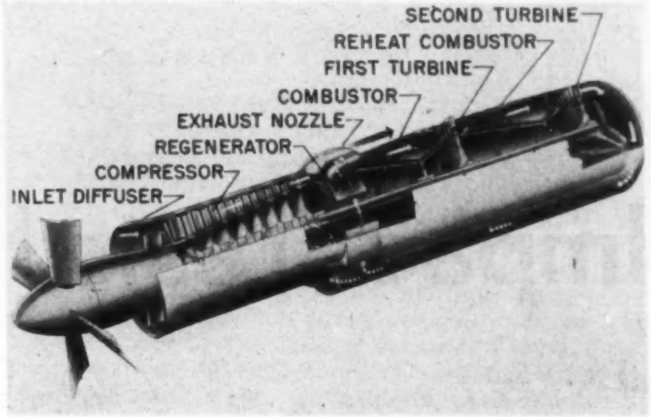
Altitude and Fuel Consumption

At an altitude of 30,000 ft, the corresponding decreases in fuel consumption were 4, 5, and 7%, respectively. The compressor pressure ratios for minimum specific fuel consumption for the regenerative-plus-reheat engine, which were 8 at sea level and 12 at an altitude of 30,000 ft, were lower than those for both the reheat and basic engines, and slightly higher than for the regenerative engine at both altitudes.

A turboprop engine with 100% reheat between turbines, and with a work distribution between turbines that gave approximately maximum range, was analyzed. It resulted at best in about 10% improvement in airplane range at low flight speeds and about 15 to 20% greater ranges at the higher flight speeds. This trend was constant as altitude was



3. Regenerative turboprop engine



4. Regenerative-plus-reheat turboprop engine

Configurations . . . How They Compare

changed. The performance calculations did not include the additional weights required for reheat equipment and controls.

A turboprop engine with regeneration, operating with a regenerative effectiveness of 0.5, gave about 3% greater range than did the basic turboprop engine at low flight speeds and about the same range at the higher flight speeds for all altitudes.

A turboprop engine, operating with a combination of regeneration and reheat, indicated a slightly greater improvement in range over that of the basic turboprop engine at all flight speeds and altitudes than that found for the reheat engine.

The range of the turboprop engine increased at a decreasing rate as the turbine-inlet temperature was increased. (No increase in engine weight was assumed to accommodate increases in turbine-inlet temperatures.) For the basic engine at a flight speed of 500 mph and an altitude of 30,000 ft, increasing the turbine-inlet tempereratur from 2000 to 2250 R (in each case compressor pressure ratio for maximum airplane range was maintained) increased the maximum range about 19%; but an increase from 2000 to 2500 R indicated a 32% increase in range. With a fixed pressure ratio of 8, the foregoing increases in temperature resulted in about half of the increase in aircraft range obtained with the optimum pressure ratio.

Presence of a regenerator in the turboprop cycle reduces the required compressor pressure ratio for maximum range to such low values, that fixing the pressure ratio at either 8 or 12 results in negligible reductions in range as the turbine-inlet temperature is increased. If pressure ratios are limited by design considerations to values of 8 or 12, the regenerative or the more complex regenerative-plus-reheat engine becomes more desirable than the other engines from a range standpoint, regardless of turbine-inlet temperature.

At an altitude of 30,000 ft, the analysis indicates that the basic turboprop engine gives greater airplane range than the simple turbojet engine up to flight speeds of 400 mph. At flight speeds of 400 to 500 mph, the engines are very competitive. For flight speeds greater than 500 mph, the turbojet engine gives greater range.

(In the complete paper, the author details the analysis which produced the results. He gives the assumptions made and expressions used in calculating performance values. Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Impact Tests Help Engineers

BASED ON PAPERS BY*

L. D. Jaffe, P. R. Kosting, A. F. Jones,
J. I. Bluhm, A. Hurlich, and J. F. Wallace, Watertown Arsenal

* Papers given at a meeting of the Iron and Steel Technical Committee's Division XXIV, "Low-Temperature Properties of Ferrous Materials." The statements or opinions in this article are those of the authors and do not necessarily express the views of the Ordnance Department.

IN the past, the notched-bar impact test has been used as a qualitative index of the tendency of steel to behave in a tough or a brittle manner. One method of employing the test for the specification of materials is to subject specimens to impact loading at the lowest temperature contemplated for the service use of the steel or at some fixed low temperature, established more by custom than for any fundamental reason, and accept those steels which display tough behavior when thus tested. This method has often been found unsatisfactory, being at times excessively severe and at other times not nearly severe enough.

As long as the impact test is used qualitatively, it is limited to applications in which a considerable experience has been accumulated to bring out a definite relation between impact resistance and service performance. This experience had to be gained in a more or less painful manner, with examination of failed components a necessary step in the development of impact test requirements.

Because of its initially qualitative nature, the impact test has been of little use to the design engineer, who must employ quantitative considerations. During the last decade data have been accumulated and analyzed to determine the factors governing the behavior of steel, which permit the impact test to be used in a more exact and quantitative manner than was hitherto possible.

It has been demonstrated that the behavior of a metal is a function of a number of variables, including stress, stress distribution, strain, strain rate, temperature, anisotrophy, number of loading cycles, history of loading, and metallurgical factors. This relationship establishes the condition for deformation or fracture, or more specifically the condition of brittle failure.

Ferrous metals and alloys in general differ from the most widely used nonferrous metals in that they undergo a more or less sharp transition from tough to brittle behavior as the temperature is lowered, as illustrated in Fig. 1. The temperature at which this transition takes place under a particular set of loading conditions is often referred to as the transition temperature for those conditions, though the transition more accurately takes place over a range of temperatures. In the simple tension test with slow rates of load application, the transition temperature for steels is ordinarily very low, often several hundred degrees below zero. High strain rates and multiaxial stress distributions, both of which may occur in service, tend to raise the temperature at which the change from tough to brittle behavior occurs. Thus, in the notched-bar impact test, where such conditions are found, the transition temperature of steel may occur near room temperature. This is advantageous for test purposes. In service, however, a high transition temperature may lead to brittle failure.

The unexpected brittle failures of parts which occasionally occur, and become increasingly frequent under conditions of shock loading and low temperatures, are associated with the fact that stresses in excess of the yield strength of the material are built up in local regions around stress concentrators. Typical stress concentrators are intentional or accidental internal corners, machine tool marks, weld craters, and metallurgical irregularities such as inclusions. When, at the strain rates and temperatures which prevail in service,

Specify Steel

the steel part is below the temperature of transition from tough to brittle behavior, a crack will initiate at the region of local overstressing and will propagate very quickly through the part, leading to a catastrophic failure. To avoid such sudden brittle fractures, it is necessary that the steel be sufficiently tough to permit a slight plastic deformation in the region of local overstressing. This will relieve the stress concentration and so avoid the initiation of a crack.

It has been found experimentally that there exists a specific relationship between the transition temperature and the strain rate, as shown in Fig. 2, which may be expressed mathematically in the following fashion:

$$\frac{1000}{T_2} - \frac{1000}{T_1} = C \log \frac{\dot{\epsilon}_1}{\dot{\epsilon}_2} \qquad (1)$$

where:
T_1 = Temperature (absolute) at strain rate $\dot{\epsilon}_1$
T_2 = Temperature (absolute) at strain rate $\dot{\epsilon}_2$
C = Constant of material

This means that at a strain rate $\dot{\epsilon}_1$ and temperature T_1 the fracture behavior of the material, whether tough, brittle, or transition, is the same as at strain rate $\dot{\epsilon}_2$ and temperature T_2.

Based upon the foregoing, a method has been proposed at Watertown Arsenal Laboratory whereby the notched-bar impact test may be employed quantitatively in the specification of steel for service under shock loading or at low temperatures. Use is made of the concept of an "equivalent Charpy temperature," which is the temperature at which a V-notched Charpy impact test specimen has fracture behavior similar to that of a given part loaded in its usual service fashion at the lowest anticipated service temperature. To calculate the equivalent Charpy temperature is is necessary to know or to compute the strain rate in the Charpy impact test, the strain rate in the part, and the lowest anticipated service temperature of the part. Thus, from equation (1), we have:

$$\frac{1000}{T_c} - \frac{1000}{T} = C \log \frac{\dot{\epsilon}}{650} \qquad (2)$$

where:
T_c = Equivalent Charpy temperature, F (absolute)
T = Anticipated lowest operating temperature of part, F (absolute)
$\dot{\epsilon}$ = Strain rate of part in service, per sec

The lowest anticipated service temperature of

The Charpy Test . . .

THE Charpy notched-bar impact test—long used as a qualitative aid in specifying steel of the proper toughness to withstand shockloading—can now be used in a more exact and quantitative manner by means of two design tools developed at Watertown Arsenal Laboratory. These are:

1. A chart showing the relationship between the impact energy that should be possessed by the Charpy V-notched impact specimen and the strength of the steel from which it is made—under certain conditions of test discussed in the accompanying article.

2. An equation that gives the temperature at which the impact specimen should be broken.

The chart of impact energy versus strength is based on an analysis of the impact properties of both wrought and cast steels.

The temperature equation—which has been put in the form of a graph to make its use easier—is based on these facts: (1) steel undergoes a transition from tough to brittle behavior as the temperature of the metal is lowered to a certain point, and (2) this transition temperature has a known dependence upon the rate of stressing.

Brittle failures, which are more common at low temperatures, start at planned or unplanned stress concentrations that cause local overstressing. They do not occur if the part, under service conditions, is ductile enough to deform locally and relieve the stress concentrations without breaking. The design engineer can protect himself against brittle failures by specifying the mimimum impact energy required of the V-notched Charpy specimen and the temperature at which the specimen should be broken.

As disclosed in the accompanying report, the procedure to be used in establishing these two characteristics is as follows:

1. Determine in the usual manner the required yield or tensile strength of the steel.

2. Using this value of strength, determine from Figs. 5 or 6 the minimum impact energy that must be possessed by the steel at a temperature which is determined in step 5 below.

3. Determine the stress rate of the part by dividing the strength by the time of load application. This figure is not needed to a high degree of accuracy.

4. Decide the lowest service temperature that the part will have to sustain.

5. Using these values, determine from Fig. 7 the temperature at which the impact test should be made.

the part is, of course, known. The strain rate in the Charpy impact test has been determined by means of strain gage measurements and photoelastic techniques as 650 per sec, and this value has been used in equation (2). The strain rate of a part may easily be computed; dividing the maximum stress by the elastic modulus gives the maximum strain which the part undergoes in service, and dividing the strain by the time interval during which the load is applied gives the strain rate of the part. It is not necessary to know the strain rate in the part to high accuracy to determine the equivalent Charpy temperature. Even if the strain rate were off by a factor of 2, the equivalent Charpy temperature would be off only 4–8 F. The constant C has been found to have a value, depending upon the source of the data, between 1/4 and 1/20 per deg (F). For applications where the strain rate is less than 650 per sec, the value $C = 1/20$ gives conservative results and is consequently to be employed for the bulk of engineering calculations. The value $C = 1/4$ gives conservative results when strain rates are greater than 650 per sec.

Since strain rates in the elastic range are proportional to stress rates, equation (2) may be rewritten as:

$$\frac{1000}{T_c} - \frac{1000}{T} = C \log \frac{\dot{\sigma}}{19.5 \times 10^9} \qquad (3)$$

where:

$\dot{\sigma}$ = Stress rate of part in service, psi per sec and is obtained by dividing the maximum tensile stress in service by the time in which the load is applied. The value 19.5×10^9 is the stress rate in the Charpy bar, equal to 650 per sec times 30,000,000 psi, the elastic modulus.

Equations (2) and (3) oversimplify the behavior of the steel in that they ignore differences in stress distribution between the Charpy specimen and the part. To take an extreme case, a part loaded in hydrostatic compression will not fracture. The effect of stress distribution on transition temperature is not yet known quantitatively. The V-notch Charpy specimen is subjected to a stress system as severe or more severe than most engineering parts (Fig. 3). Accordingly, it is in general conservative to make the tacit assumption that the stress system in the part may be represented by that in the Charpy bar.

Statistical studies have shown that there is a definite relationship between the toughness, as measured in the impact test, and the hardness or strength of steel when the impact testing is done at temperatures above the transition temperature range so that the specimens behave in a tough manner. When V-notch Charpy impact energy above the transition range is plotted versus strength, the data fall in a narrow band with the impact energy decreasing with increasing hardness or strength. (See Fig. 4.)

Since only a moderate amount of plastic deformation in the vicinity of stress concentrators is enough

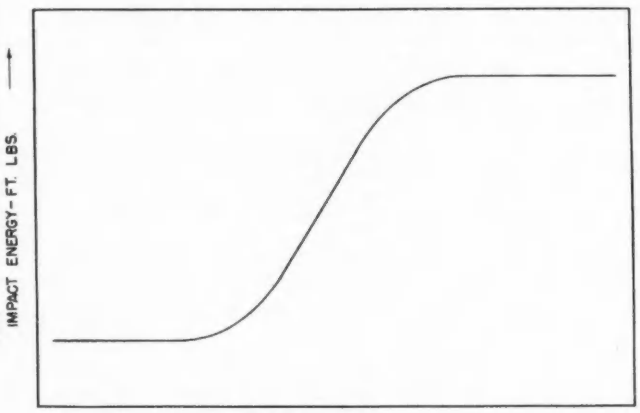


Fig. 1—Schematic plot showing transition behavior of steel

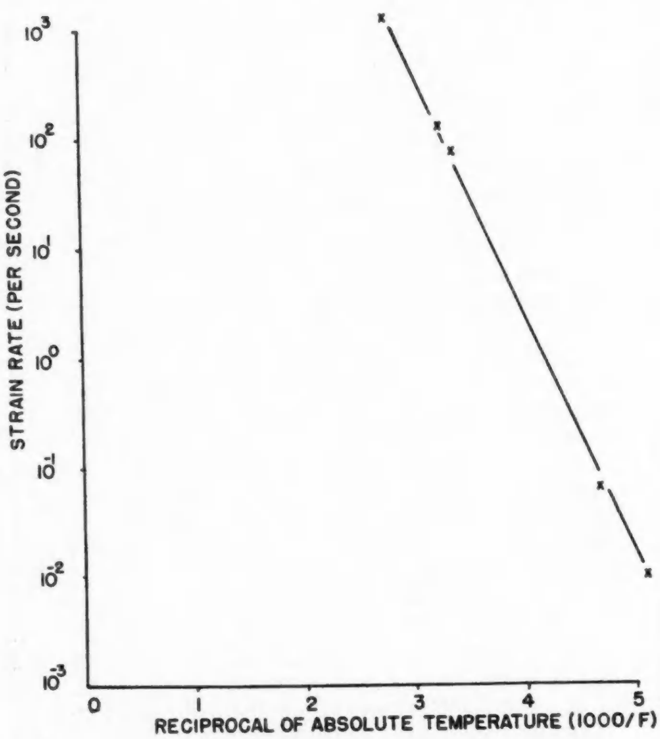


Fig. 2—Plot of data covering relationship between transition temperature and strain rate, which leads to equation $\frac{1000}{T_2} - \frac{1000}{T_1} = C \log \frac{\dot{\varepsilon}_1}{\dot{\varepsilon}_2}$ (after Witman and Stepanoff)

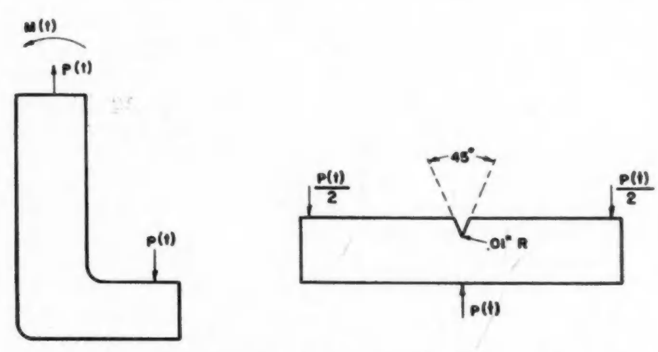


Fig. 3—Chart showing mechanical relationship between (left) actual steel part subjected to embrittling factors and (right) standard V-notch Charpy impact test specimen subjected to same but more severe factors P(t) = Force as function of time

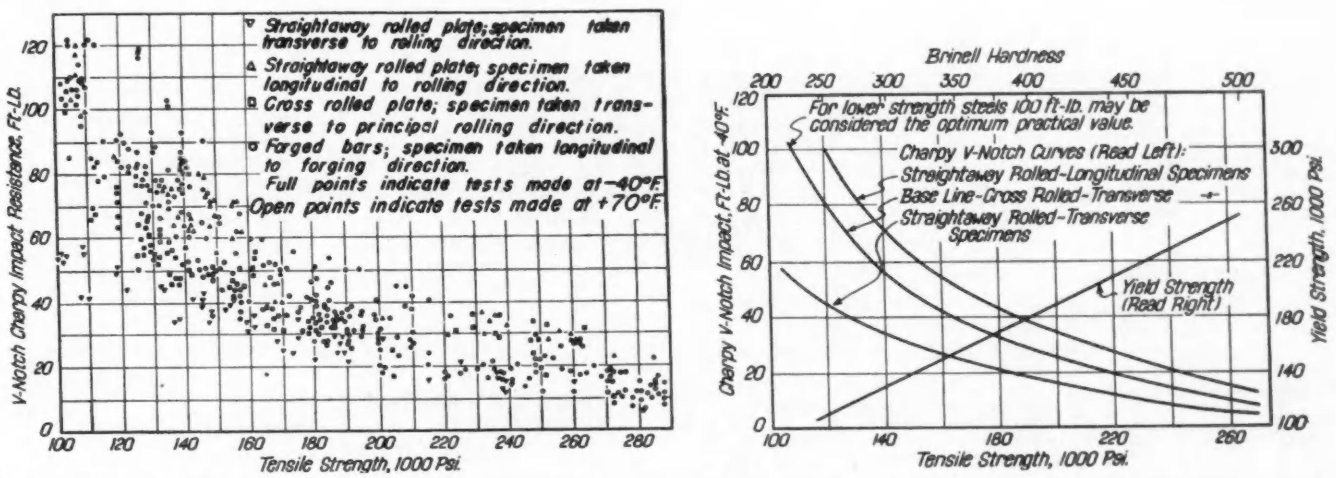


Fig. 4—Charts showing relationship between impact energy and tensile strength of steel not subjected to embrittlement during tempering, when tests are conducted above transition temperature—left graph: actual plot of points for various steels; right graph: curves giving relationship of yield strength, Charpy V-notch impact resistance, hardness, and tensile strength of properly heat-treated and reasonably clean steel

to prevent the initiation of a brittle crack, it is not necessary that the Charpy test specimen be fully tough at the equivalent Charpy temperature. In the method proposed by Watertown Arsenal Laboratory, an impact energy halfway between the values of the fully tough and the completely brittle conditions is chosen as adequate for the application. As shown in Figs. 5 and 6, curves of the fully tough *A* and fully brittle *C* conditions in the V-notch Charpy impact test versus hardness or tensile strength have been prepared from existing data covering the impact properties of wrought and cast steel, and the midpoint curves *B* obtained from these. The *B* curves show the impact energy that should be obtained for a *measured* tensile strength. If Figs. 5 and 6 are used to determine the expected energy for a specified *minimum* strength, the actual strength will ordinarily be 10,000–15,000 psi above the minimum, and a correspondingly lower energy should be permitted. Curve *B′* (obtained by shifting curve *B* 15,000 psi downward) should then be used. If, as is often recommended, yield strength rather than tensile strength is controlled, conversion may be made by Fig. 4.

Thus, to use the proposed method in specifying the pertinent characteristics of steel for a given application, the design engineer determines the required yield or tensile strength of the steel in the usual manner. With this value of strength, he resorts to prepared curves of impact energy versus strength and determines the minimum impact energy which the steel should have. By use of the equation relating the stress rates and temperatures of the part and of the V-notch Charpy impact specimen, the engineer then determines the temperature at which the impact specimen must be broken. Determination of the equivalent Charpy temperature has been simplified by the preparation at Watertown Arsenal Laboratory of a master chart, Fig. 7, which shows the relation between the operating temperature, the stress rate or strain rate in the part, and the equivalent Charpy temperature. The discontinuity in the curve at a strain rate of 650 per sec arises from the use of a different value of the

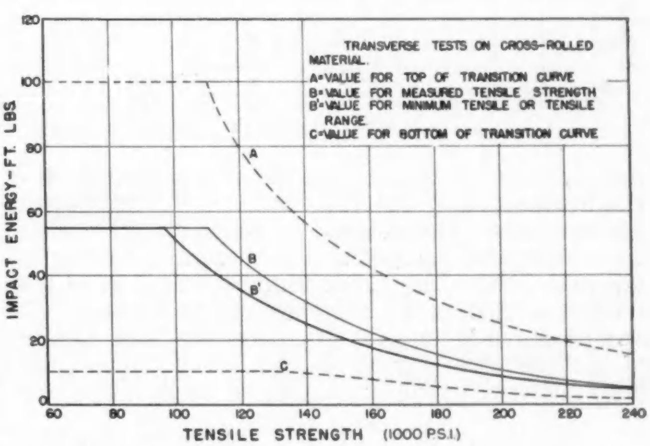


Fig. 5—Chart for determining V-notch Charpy impact energy requirements, for cross-rolled steel

constant *C* at higher strain rates in order to assure conservative design.

To introduce a safety factor in the selection of steel requiring toughness, it is proposed that the actual temperature for the impact test be taken as 20 F lower than the equivalent Charpy temperature. On this basis a scale of recommened test temperatures has been included in Fig. 7.

An example of the suggested method for determimining specification requirements is as follows: Suppose the part must have a minimum tensile strength of 120,000 psi, the load is applied in 0.1 sec, the minimum temperature of service is -30 F, and transverse properties are of interest. Fig. 5 (curve *B′*) shows that for a minimum tensile strength of 120,000 psi, the appropriate impact energy is 35 ft-lb. When 120,000 psi is divided by the time 0.1 sec, the stress rate $\dot{\sigma}$ is found to be 1.2×10^6 psi per sec. Fig. 7 shows for this stress rate and a service temperature of − 30 F at the recommended test temperature of − 10 F. The specification would then read:

Minimum Tensile Strength, psi	120,000
Minimum Charpy V-notch at − 10 F, ft-lb	35
Test Specimen Direction	Transverse

The authors advocate specifying steel for given

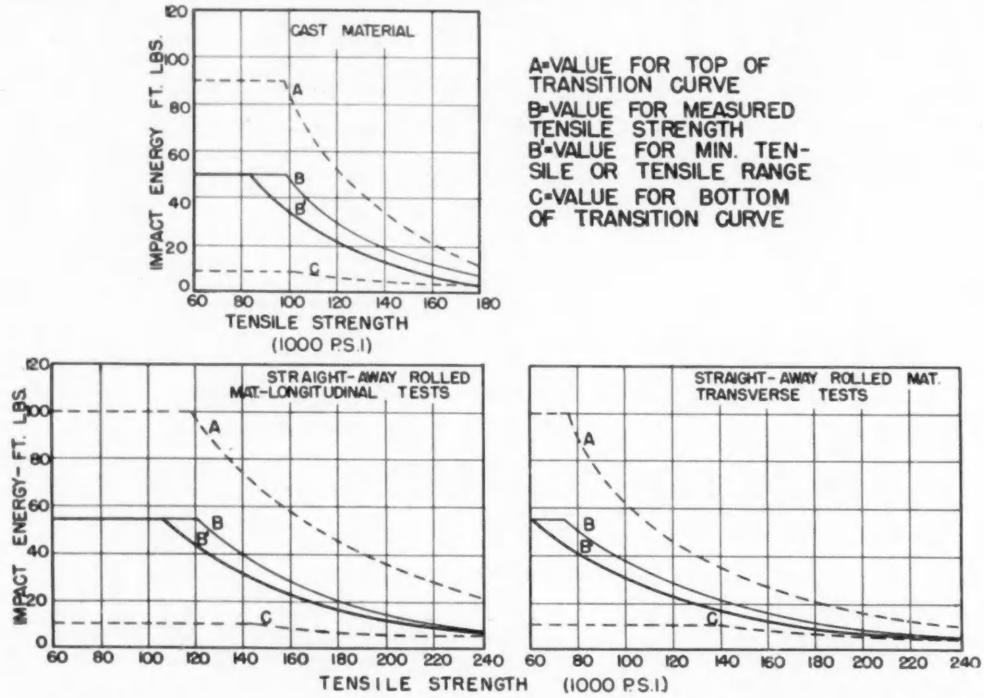


Fig. 6—Chart for determining V-notch Charpy impact energy requirements, for cast and for straight-away-rolled steel

applications by designating the minimum values of the mechanical properties required for satisfactory performance. Designation of steels on the basis of their chemical composition is generally totally inadequate, since any given composition of steel may possess a wide range of toughness or brittleness at any strength level, depending upon a large number of metallurgical variables. By specifying a minimum yield or tensile strength, an impact test temperature, and a minimum impact energy, the design engineer fixes the properties needed to avoid the unexpected brittle failures which plagued him in the past when conventional design procedures were employed. By specifying these properties, the design engineer properly transfers to the metallurgist or metallurgical engineer the responsibility for choosing, processing, and heat-treating steel so as to obtain the desired properties.

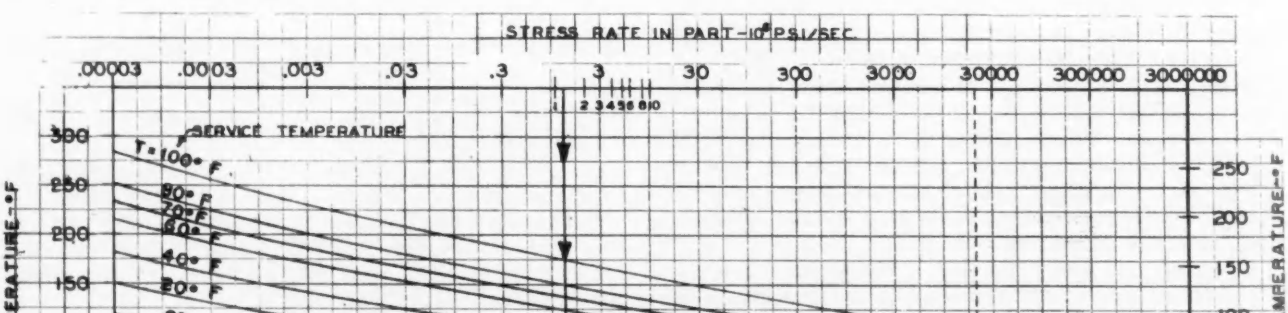


Fig. 7—Solution of equations (2) and (3) for determination of equivalent Charpy temperature and recommended V-notch Charpy test temperature when service temperature and strain rate or stress rate of part are known. Heavy line indicates solution for part strained at rate of 1.2×10^6 psi per sec. For service temperature of −30 F, Charpy test temperature of −10 F is indicated

BRITISH diesel-engine design has been influenced by a number of special factors, according to Mr. Dicksee:

- Legislative limitations on speed (20–30 mph), gross weight, and overall vehicle dimensions.
- Absence of mountain ranges, with their long, steep grades and areas at considerable altitude.
- High cost of fuel—caused mainly by the imposition of the highest fuel tax in the world.

The first two factors have, of course, reduced the size of engine needed, as well as its performance requirements, although Mr. Dicksee emphasizes that British engines have been found capable of much higher speeds than called for, and of negotiating even the high altitudes encountered on roads across the Alps.

It is the third factor that has been the real challenge to the British designer, for it has meant evaluating every design and every design change in terms of its effect on fuel consumption.

Important in attaining outstanding fuel consumption has been the adoption of the open combustion chamber, which, Mr. Dicksee shows, the British have developed to a very high degree.

Presented here is the part of Mr. Dicksee's paper that covers the sources of efficiency of the open chamber.

In the complete paper he also presents the British viewpoint on smoke and odor, fuels, cylinder wear, and lubricating oils.

Why the British Use Open-Chamber Diesels

EXCERPTS FROM PAPER* BY

C. B. Dicksee, A. E. C. Ltd.

* Paper, "Current State of Automotive Diesel-Engine Design and Performance in Great Britain," was presented at the SAE Annual Meeting, Detroit, Jan. 8, 1951. This paper will be published in full in SAE Quarterly Transactions.

UNIVERSAL adoption of the open chamber for engines for the heavier classes of vehicles lies in the improvement in efficiency of which the open chamber is capable. Briefly, this improvement is due to three causes:

- The open chamber dispenses with an intermediate stage in the combustion process and burns the fuel directly from the liquid state.
- It does not reserve a part of its air supply for use at a relatively late period in the cycle.
- The heat carried away in the coolant is reduced to a very low figure.

The first two reasons mean that combustion is completed at an early stage in the cycle and the engine therefore derives maximum benefit from its high expansion ratio.

The true extent of the benefit derived from the third cause is not easy to assess because not all of the heat carried away in the cooling water is actually a cooling loss and the benefit derived from any reduction in the heat carried away by the coolant is not therefore directly in the ratio of any such reduction. Whether or not the heat in the coolant is a loss depends upon where in the cycle the heat reaches the coolant. Further, a reduction in the heat to the coolant may mean nothing more than that more heat is carried away by the exhaust gases.

Working on a given cycle of operation, an engine is capable of converting into work a certain proportion of the heat it receives and it is quite immaterial to the engine how the remaining heat is disposed of, whether to coolant or to exhaust, and a quite considerable variation in the ratio of the division of this heat between exhaust and coolant is possible without affecting the efficiency.

At the same time, the surface/volume ratio of the open chamber is very much more favorable towards a low value for the true heat loss than is that of the more complicated forms of chamber, and with the completion of the combustion early in the cycle the maximum temperature is recorded at a time when

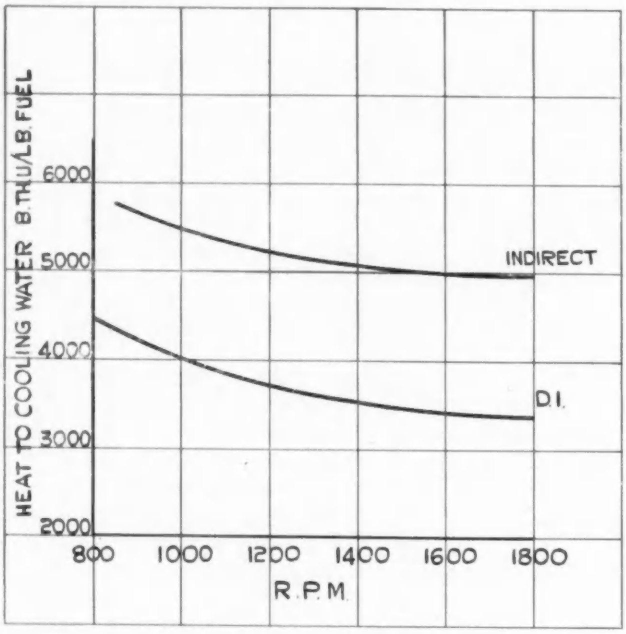


Fig. 1—Heat to cooling water per pound of fuel with different types of combustion chamber

the wall area exposed to the hot gas is a minimum and the heat loss will, therefore, be less than if the combustion period is prolonged. Heat lost during the combustion period will, of course, represent a real loss.

The relative values of heat to coolant for two engines of the same bore and stroke, the one an open chamber and the other an indirect chamber, albeit one giving a higher efficiency than a precombustion chamber, are shown in Figs. 1 and 2. Fig. 1 shows the heat carried away per pound of fuel supplied to the engine and Fig. 2 shows the corresponding specific consumptions, and the ratio between heat to water and heat to work and also the exhaust temperature. Fig. 1 shows that the heat carried away in the cooling water per pound of fuel is some 30% less in the case of the open-chamber engine and Fig. 2 shows that the ratio of heat to water/heat to work over most of the speed range is of the order of 0.55/1 for the open chamber against 0.82/1 for the indirect chamber. On the other hand, the exhaust temperature of the indirect-chamber engine is rather less than that of the open chamber, roughly 50 C, illustrating the point made above that jacket heat and exhaust can be mutually interchangeable. The difference in fuel consumption is in the order of 10%. In yet earlier types of indirect chamber the ratio of heat to water/heat to work was of the order of 1/1 and in the very earliest engine built by the author's firm, an air-cell engine, the ratio was 1.2/1.

Precombustion-Chamber Type

Returning now to the first two reasons, let us examine the combustion process in the different chambers. In the precombustion-chamber type the fuel is delivered into the precombustion chamber, the walls of which are maintained at a high temperature in order to assist the vaporization and the ignition of the fuel. On ignition the rise in pressure ejects the charge into the main chamber in the form of a very rich mixture of fuel vapor and air plus a certain amount of still liquid fuel. Before combustion can be completed this rich mixture must mix with the air in the main chamber and the rate of combustion will be governed by the rate of this mixing. The mixing takes time and, while the process is taking place, the piston is moving outwards on the expansion stroke and the amount of expansion available after combustion is steadily decreasing.

It is hardly necessary to state that the efficiency of all heat engines is governed by the expansion ratio of the gases following the reception of the heat. The maximum efficiency will thus be derived when all heat is added at top dead center, that is, at constant volume. This, however, is neither practical nor desirable in an actual engine and, in order to limit the maximum pressure, reception of heat is spread over a short period at the beginning of the expansion stroke, but the longer this period lasts the lower will be the effective expansion ratio and the lower will be the efficiency of the engine.

The influence upon efficiency of prolonged burning is well illustrated by Fig. 3, which shows the efficiency theoretically attainable by an engine having a compression ratio of 16/1 and utilizing 60% of the available air when the combustion of the fuel varies from 100% at constant volume to 100% at constant pressure; the values given are those obtained when allowance is made for the change in specific heats of the gases. The corresponding expansion ratio during the combustion period is shown also. This diagram shows that, whereas the efficiency reaches nearly 56.5% when all heat is added at constant volume, it falls to 49.2% when all heat is added at constant pressure; for this latter condition the expansion ratio during combustion is 2.6/1. The decrease in efficiency when 50% of the heat is added at constant pressure is, however, small, the expansion ratio during combustion for this condition being of the order of 1.3/1. The figures shown in this diagram are based upon the assumption that pressure remains constant during the combustion period, and it will be realized that any fall in pressure during combustion will prolong the combustion period yet further and cause a further drop in efficiency below the values shown.

The mixture is not discharged instantaneously from the precombustion chamber, the rate of discharge being governed by the pressure difference and the restriction at the opening between the two chambers. Combustion in the main chamber reduces this pressure difference and would establish equilibrium between the two chambers if it was not for the outward movement of the piston, which maintains a difference in pressure. The discharge of fuel from the precombustion chamber is, therefore, governed to a large extent by the outward movement of the piston, and the combustion period is thereby prolonged down the expansion stroke, so that the final particles of fuel will reach the main chamber relatively late in the stroke, with their ability to do useful work correspondingly reduced.

In an air-cell engine something very similar takes place. Part of the air is transferred to a small

chamber, which is connected to the main chamber by a restricted orifice. Into the main chamber, which contains about two-thirds of the total volume and is in direct connection with the cylinder bore, the fuel is delivered and is directed towards the opening into this small chamber or air cell. The exact process of combustion seems to be somewhat obscure but it would appear that some measure of vaporization takes place by virtue of the impact of the fuel upon the heated metal around the mouth of the air cell and that ignition originates either just inside or just outside the mouth. The function of the air cell is to provide a jet of air to break up the partially vaporized mass of fuel around the mouth of the cell and distribute it throughout the main chamber and so somplete the combustion. One point that is clear is that little or none of the combustion takes place inside the air cell. This being so, the discharge of air from the cell can take place only as the pressure falls, by virtue of the outward movement of the piston or the cooling of the gas, and the air in the cell remains inaccessible to the fuel until relatively late in the cycle; the effective expansion ratio is thereby reduced and the efficiency suffers, just as in the precombustion chamber.

In the open combustion chamber no intermediate stage in the combustion process is employed. The fuel is burned directly from the surface of the liquid droplet, nothing more than an envelope of vapor forming around each droplet. This envelope is immediately torn away and burned by the scrubbing action of the air, to reform again immediately and be torn away again, the process continuing until the droplet is consumed. During the delay period preceding ignition a certain amount of vapor will accumulate and mix with the air but, unlike the other two chambers, the resulting mixture is extremely weak, and, in the presence of the hot, dense air, conditions are favorable for rapid and complete combustion of the vapor as soon as ignition occurs. In all engines it is the initial rapid combustion of vapor which is responsible for the diesel knock and it is owing to the presence of an ample supply of air that this knock sometimes tends to be rather more pronounced in the open-chamber engine.

In order that the combustion may proceed rapidly and cleanly it is essential that the fuel particles should meet with a continual supply of fresh air. It is useless to scrub the surface with used-up air because the only effect would be to extinguish the flame and produce unburned fuel vapor. An indiscriminate turbulance, such as is so beneficial in a gasoline engine and is of some assistance to a precombustion-chamber or air-cell engine, is quite useless for an open-chamber engine if a wide speed range and a high smoke-free mean pressure are to be obtained.

To develop this scrubbing action a high velocity of the fuel relative to the air is required and, in order that the fuel particles may be completely consumed in the very short time that can be allowed for it if a high efficiency is to be realized, a fine degree of atomization is needed.

The high fuel velocity is readily obtained by the use of spray holes of small diameter, an expedient which also gives a fine degree of atomization.

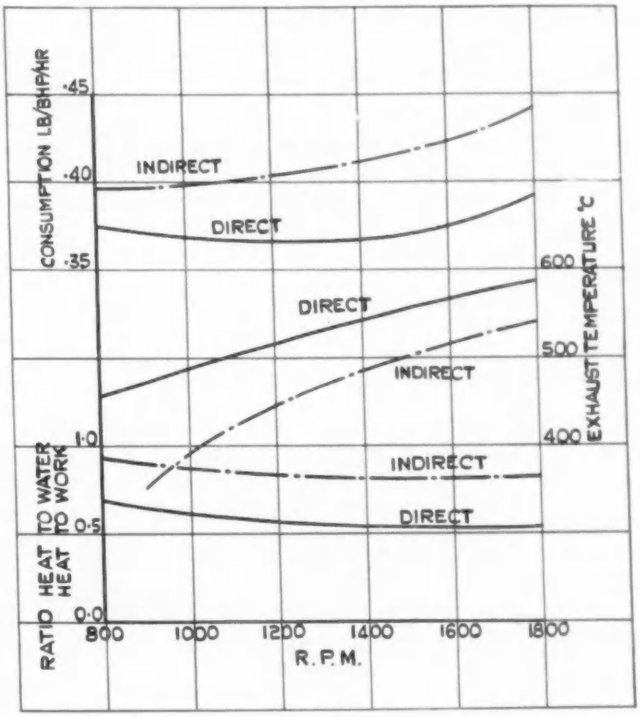


Fig. 2—Heat distribution with different types of combustion chamber

The steady supply of fresh air is obtained by giving the air an ordered swirling movement in a direction at right angles to that of the fuel sprays and the fuel is then distributed uniformly throughout the air as if flows by. In most engines this air movement is obtained by directing the air into the cylinder in a tangential direction during induction and thereby inducing a rotary movement about the axis of the cylinder. The delivery of the fuel and the movement of the air are, of course, matched to each other, the air rotating during the injection period through an arc approximately equal to 360° divided by the number of spray holes. By this means the overcharging of one part of the air and the starving of another are avoided, or at any rate reduced to a minimum.

It is this ordered movement of the air, coordinated with that of the fuel, which is the secret of the success of the open combustion chamber in the automotive field. Open chambers without this coordination had been in production for many years before the automotive development was started and had been well known for their very low fuel consumption, but their speed range had been narrow and their air utilization was of a low order, resulting in a maximum smoke-free mean pressure of no more than 70 to 75 psi. This limited performance was entirely due to the inability of the nozzle, unless assisted by some other agency, either to distribute the fuel uniformly throughout the body of the air or to maintain, over any appreciable range of speeds, a balance between the fuel and the air. The addition of an ordered movement provides the necessary assistance and not only makes possible a better use of the air but it also enables the balance between the

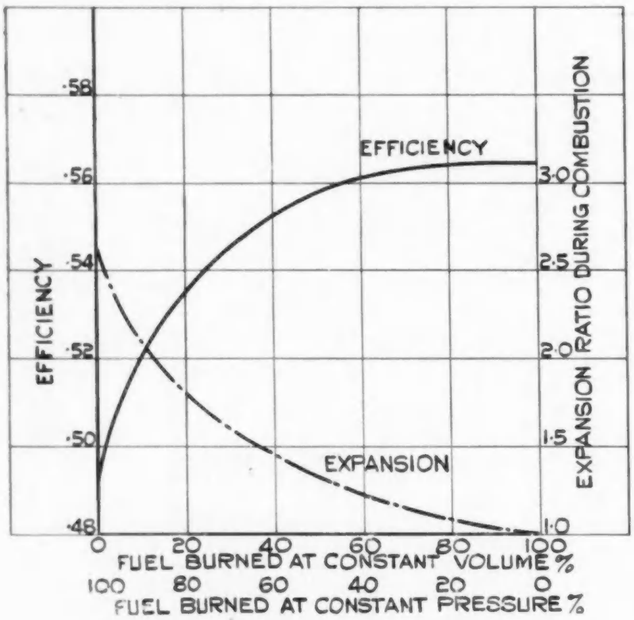


Fig. 3—Influence upon efficiency of the proportion of fuel burned at constant pressure

air and the fuel to be maintained over a greatly increased speed range.

The balance between the air and the fuel is maintained by virtue of the fact that, being produced by the movement of the piston, an ordered movement of the air will automatically increase in direct proportion to any increase in engine speed. The rate of fuel delivery also is a function of engine speed (subject to a certain amount of deviation at high speeds caused by the compressability of the fuel) and the balance between fuel delivery and air movement therefore remains substantially unchanged by a change in speed.

The tangential direction of the air is obtained either by masking a part of the periphery of the valve or by so shaping or masking the port itself as to give the desired directional effect. The methods adopted for producing the swirl are illustrated in Fig. 4. The resulting rotational effect is augmented by the transfer of the air during the compression stroke to a chamber of limited diameter machined in the crown of the piston. Theoretically, decreasing the radius of gyration of a rotating mass increases the angular velocity in proportion to the square of the two radii but, owing to losses in transfer, the actual change appears to be more or less directly as the radii.

As large a proportion of the air as possible is transferred to this recess, and to this end the piston is brought at top dead center as close as possible to the cylinder head. The clearance is usually between 0.040 and 0.060 in., but even at this close approach a not inconsiderable proportion of the air remains outside the combustion chamber in the piston and head clearance, in the top land clearance, the necessary valve-head clearances, and so on. In our own engines around 82% is brought into the chamber: the actual proportion achieved being influenced by the compression ratio as well as by mechanical details. Other things being equal, the higher the compression ratio the smaller will be the proportion brought into the combustion recess. The rate of transfer reaches a maximum shortly before top dead center, and this squeezing out action as the piston approaches the cylinder head, known as squish, brings the air movement to its maximum during the actual injection period. Although it is the velocity with which the air passes over the rim of the combustion recess, that is, the squish velocity, that is the governing factor that determines the swirl, the performance of the engine is not affected by small changes in piston-cylinder-head clearance, is not, therefore, subject to normal gasket thickness variations but chamfering or rounding off the edge of the combustion recess can produce a very material difference in performance.

To retain a good performance over a wide speed range something more is needed than the maintenance of a uniform distribution of the fuel throughout the air. To maintain a constant thermal efficiency it is necessary so to regulate the rate of burning that the combustion period occupies the same period in the cycle at all engine speeds. Any increase in the combustion period, as measured in terms of the time for a single cycle, will result in a decrease in efficiency. The time occupied by combustion must, therefore, vary inversely as the engine speed. The fact that the relative velocity between the fuel and air increases directly with the engine speed is probably the chief factor in maintaining the combustion at the correct rate, but considerable assistance is derived from the finer degree of atomization which follows the increase in injection rate consequent upon an increase in speed. The combined effort of these two factors serves to maintain the combustion period substantially constant over a speed range appreciably wider than is normally required.

From the foregoing it will be understood that, in order that an open chamber may give a high specific performance, the chamber must be made as compact as possible; and that, to permit the production and maintenance of a well-ordered air movement free from whirls and eddies, the chamber must have the form of a figure of generation. It must be free from any irregularities which could disturb or damp down the ordered movement and, if the maximum possible use is to be made of the air, all pockets which would serve to separate a part of the air from the main body must be avoided, as far as it is possible to do so, because the air contained in such a pocket can neither be made directly available to the fuel spray nor can it be made to partake of the desired air movement and is therefore lost in so far as combustion is concerned or, at best, will become available too late in the cycle to make its proper contribution to the work done.

The use of a combustion chamber of diameter smaller than that of the cylinder has the advantage that it reduces the distance that the fuel spray is called upon to penetrate. This is a point of some importance because the volume of air to be supplied with fuel increases as the cube of the distance from the nozzle. The distance that an individual fuel particle can penetrate in the dense air is very limited and is governed by the kinetic energy of the

article as well as the density of the air. The penetration is increased somewhat by the mass effect of the spray as a whole but under combustion conditions the particle is losing mass as it travels and its ability to stay the course decreases with the distance travelled. If therefore the distance between the nozzle and the chamber wall is too great a large proportion of the air may never receive its quota of fuel either because the particles are completely consumed before they reach the outer zones of the chamber or because they have insufficient energy to be able to complete the journey, any attempt to force the fuel to reach the outer zone will, as a rule, result only in overcharging the zones nearer the center.

Generally speaking it is more difficult to obtain effective penetration and distribution in a large chamber than it is to avoid overpenetration in a smaller chamber. Increasing the velocity through the nozzle so as to increase the kinetic energy of the spray, and, therefore, its penetration, does not produce the desired effect because, as already stated, it results in a finer spray. What is needed where the distance is too great is a coarser spray, and to obtain a coarser spray a lower velocity is needed. Unfortunately, the volume of a droplet is a function of the cube of its diameter, whereas its area increases only as the square. Further, the number of particles decreases in proportion to the cube of any increase in diameter and the effectiveness of the exploration of the chamber is reduced accordingly.

The distance the spray has to travel should, therefore, be kept small rather than large. Overpenetration, or at least some measure of overpenetration, is not necessarily a bad thing. If its temperature is high enough the surface against which the spray strikes will not be wetted by the fuel because of the envelope of vapor with which the particles are surrounded prevents actual contact by the liquid. In the open combustion chamber the surface involved is the piston crown and at the higher loads, when the chances of impact are at a maximum, this is at a temperature high enough to prevent wetting by the fuel. An examination of the piston after a period of service does show a certain amount of evidence of fuel impact, and it appears likely that some of the heavier droplets do reach the far wall but rebound from the hot surface to finish their combustion in the normal manner. This rebounding may very well assist in the distribution of the fuel in the zone most difficult to feed because any particle which rebounds will pass twice through part of the outermost layers of air. It is possible also that the particle may be broken up by the impact and so assist yet further in the distribution and combustion process.

With a single exception, all the engines studied have a fixed injection timing, no provision being made to vary the timing as the speed changes. In one other instance the timing is advanced as the load is increased but at any given fuel delivery the timing remains the same at all speeds. The ability to use a fixed injection timing is helped considerably by the limitation of the maximum speed to 1800 rpm. Although in the case of the engines produced by the author's firm there is some gain from advancing the timing for speeds of 2000 and upwards, the gain at 1800 rpm is too small to justify the additional cost and complication. The timing chosen is to some extent a compromise but entails no real sacrifice.

The ability to do without the variable timing device lies mainly in the avoidance of a vaporization phase in the combustion process. In both the precombustion-chamber and air-cell engines the absence of an ordered and controlled air and fuel movement means that the combustion rate is largely independent of engine speed; in order, therefore, that it may be completed at a point reasonably early in the cycle, combustion has to start earlier as the speed increases. There is, however, one other factor to be considered, and that is the delay period. The delay period tends to remain constant in time and therefore to occupy an increasing proportion of the cycle time as the speed increases. Some measure of compensation is obtained from the increase in compression temperature and from the finer degree of atomization which follows an increase in speed. These tend not only to reduce the delay period but also to increase the rate of combustion after ignition has taken place.

We ourselves have found no indication of any real falling of combustion efficiency up to 2200 rpm, the maximum speed at which we have run our engines. It is, of course, possible that without some means for varying the timing some difficulty might be encountered in service at high speeds and light loads when using fuels of really low octane value.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

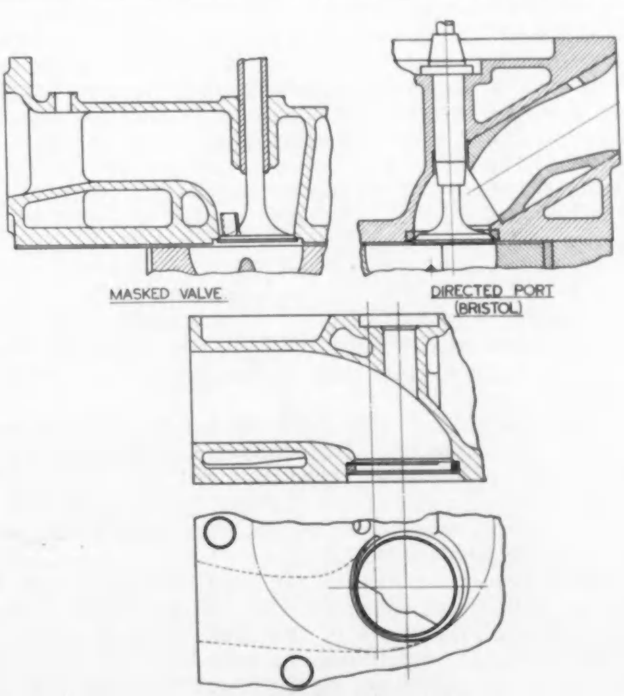


Fig. 4—Methods of inducing air swirl

BASED ON PAPERS* BY

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How To ... On RR

* Papers, "Heavy-Duty Oils in Railroad Diesel Engines," by Wayne Lasky, M. A. Hanson, and H. E. Frank; and "Estimating Additive Depletion in Heavy-Duty Oils Used in Railroad Service," by L. A. Wendt, were presented at the SAE National Diesel Engine Meeting, Chicago, Nov. 2, 1950.

BY the periodic addition of additives to the heavy-duty oils used in diesel engines on railroad freight service, superior engine conditions can be maintained, even through oil changes are eliminated.

As developed in the course of a cooperative program between the Gulf, Mobile, & Ohio Railroad and the Shell Oil Co., the method consists of adding to the crankcase 15 gal of a concentrate containing five times the amount of additive contained in new oil, at each 5000–6000-mile filter change. All other make-up oil is the regular heavy-duty type.

Tests were run on five high-output diesel units in good mechanical condition operating in heavy freight service. These units included two different engine builders' locomotives, each powered by a 1500-hp diesel engine.

A full charge of 200 gal of new lubricating oil and new oil filters were applied at the start of the tests.

Several of the engines were operated for extended oil mileages before the oil was drained, including one run of 136,698 miles, another of 118,474 miles, and a third of 117,078 miles. In each instance the oil was drained because of scheduled mechanical work, excessive fuel dilution, or water in the oil—not because of poor oil quality.

Periodic inspection of these engines during the entire test has shown them to be satisfactorily clean. Sludge deposits and lacquer conditions have at all times been at least comparable to conditions existing on engines operating on heavy-duty oil with periodic changes.

Examination of the parts removed from the engines disclosed the pistons, rods, and bearings to be at least as clean as those removed from engines that had regular oil changes every 30,000 miles and much cleaner than those run for extended milages without additive additions.

Fig. 1 shows two pistons removed from high-output freight diesel engines. The piston on the left was removed from one of the units on test—after 94,600 miles of continuous service without an oil change. The piston on the right was removed from an engine at comparable milage that had the heavy-duty oil change every 30,000 miles. The condition of both pistons is satisfactory. The skirt of the piston from the test engine is somewhat cleaner, however, and there are less deposits in the ring grooves and on the area above the rings.

Fig. 2 shows the analyses for naphtha insolubles, chloroform solubles, and chloroform insolubles of oil samples removed periodically from the crankcase of a high-output diesel engine in heavy freight service (without crankcase fortification) from the time the oil was applied to approximately 50,000 miles of service, at which time the oil was drained because of poor oil quality.

Fig. 3 shows the same analyses of oil samples removed from one of the high-output diesel engines in the crankcase fortification test. The samples start at 6000 miles and continue until the oil was drained at 114,800 miles. There was a partial oil change on account of fuel dilution at 27,000 miles.

In interpreting oil conditions, we can assume that the naphtha insolubles roughly represent the total sludge contaminants in the oil. The chloroform solubles indicate the amount of oil oxidation products, such as resins, gum, and acids. The chloroform insolubles are a measure of the carbon or soot blowby contained in the oil. Of course, in every instance the naphtha insolubles equal the chloroform solubles plus the chloroform insolubles.

Fig. 1—Pistons from 1500-hp freight engines using heavy-duty oil—left: fortification test; right: 30,000-oil changes

Eliminate Oil Changes
Freight Diesel Engines

In Fig. 2, the naphtha insolubles or total sludge increased rapidly during the first 6000 miles, however, the total sludge consisted mainly of chloroform insolubles or carbon, indicating only a small amount of chloroform soluble or resins was being produced by the engine because of good oxidation stability. The rapid increase of carbon in the oil was due to its high dispersancy, which kept the carbon sludge suspended in finely divided particles that were not removed by the filter.

From about 10,000-20,000 miles the chloroform solubles increased at a low uniform rate, indicating fair oil stability. The chloroform insolubles remained rather constant, showing satisfactory dispersant qualities.

After 22,000 miles the amount of chloroform solubles or resins increased rapidly and the chloroform insolubles decreased rapidly, indicating lower oxidation stability and lower dispersant ability. At the time the oil was drained the naphtha insolubles consisted almost entirely of chloroform insolubles.

In Fig. 3 the analysis of the samples show entirely different oil characteristics with crankcase fortification.

The naphtha insolubles, consisting almost entirely of chloroform insolubles, increased rapidly for more than 40,000 miles, which indicates very good dispersant qualities. The chloroform solubles, during this period, remained rather low, indicating good oxidation stability. Between 40,000 and 55,000 miles the naphtha insolubles and chloroform insolubles decreased at about the same rate. After 55,000 miles they remained rather constant, although there was a gradual decrease until the end of the test.

During this period the chloroform solubles showed only a slight increase, indicating the oxidation stability was satisfactory during the entire test. At all times during the life of the oil, the chloroform insolubles were considerably greater than the chloroform solubles. The amount of chloroform insolubles present indicated that the oil always maintained satisfactory dispersancy.

The additives in heavy-duty oils provide, mainly, oxidation inhibition, detergent-dispersant action,

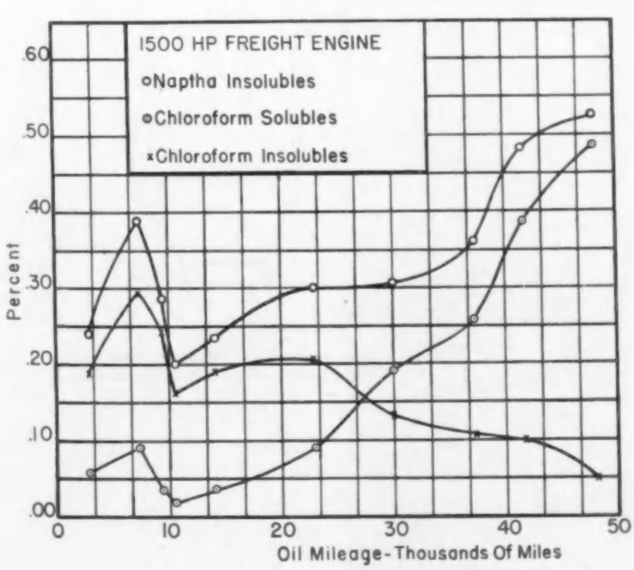


Fig. 2—Heavy-duty oil analyses versus oil mileage

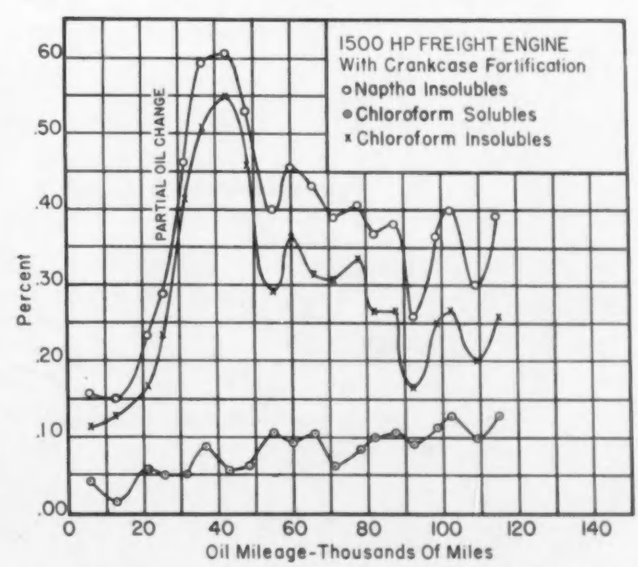


Fig. 3—Heavy-duty oil analyses with crankcase fortification versus oil mileage

and corrosion inhibition. In some cases multifunctional additives may perform two or more of these requirements. It would be desirable to evaluate each of these characteristics on used oils, but in general this is not a simple procedure.

It is possible, however, to estimate the dispersive characteristics and roughly the extent of oxidation by means of a simple blotter test, where one drop of oil is placed on absorbent filter or blotter paper. Interpretation of the spot can be made after about 5 hr if the spot is held at room temperature. Increasing the soaking temperature may decrease the time required.

For the heavy-duty oil used in this work the blotter spots were generally made up of two parts: a black spot at the center and beyond that an oily area. A sketch of a typical blotter spot is shown in Fig. 4. The nature of the black area or inner spot makes possible an estimate of the dispersive characteristics of the oil, while the color of the oily outer area indicates roughly the extent of oxidation. When the inner spot is made up of concentric bands with a lacy periphery the sample has good dispersancy. If the inner spot disappears the oil has lost most of its dispersant power.

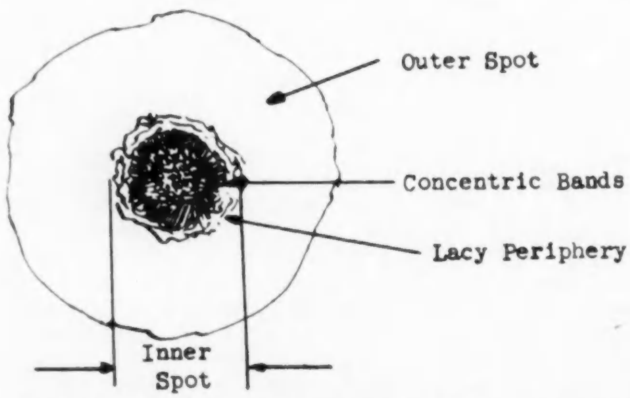


Fig. 4— Typical blotter spot for used heavy-duty oil in good condition

The oil filters used on locomotives are quite effective and will remove insolubles if the dispersant level is low; however, when the dispersant level is high an inner spot will be observed, even after a filter change. If the oil has lost its dispersive power an inner spot may be visible before a filter change but it will be uniform without concentric bands or a lacy periphery.

The blotter test can also be used for engines without effective oil filtration if the sample is first filtered through Whatman's No. 1 (medium) filter paper. Unless the sample is prefiltered the total insoluble burden in the oil may mask the dispersive action.

It has also been found that dark-field microscope inspections of used oil samples correlate rather well with the dispersive ability of the oil as estimated from blotter spot observation. This technique permits inspection of oil samples so that the extent of dispersion and/or particle agglomeration can be observed. Briefly, the procedure is to observe a thin film of the oil with a microscope set up as shown in Fig. 5. Schematically, the principle of the dark-field microscope is shown in Fig. 6.

The source of the light is so arranged that no direct beams enter the microscope. Only light that strikes a particle in its path finds its way up into the microscope barrel.

The field is dark in color and particles show up as points of light. Fig. 7 shows sketches for one series of dark-field microscope inspections made for samples taken from an engine without fortification. They are the inverse of what is actually seen in that the points of light are black spots, while the field is shown in white.

The results obtained from both the blotter tests and the dark-field microscope are much more valuable if a series of samples is studied. If only one sample is considered, it is possible to draw erroneous conclusions. In general, an acid number determination for additive-type oils is not useful for measuring dispersant effectiveness. The blotter test and the dark-field microscope should, however, be useful

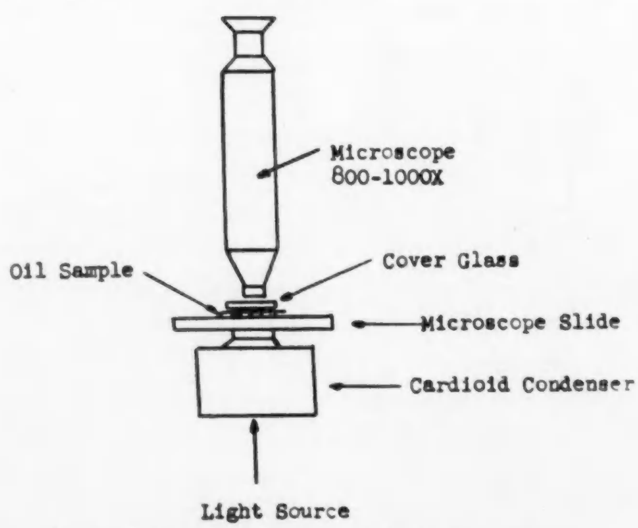


Fig. 5—Arrangement of dark-field microscope

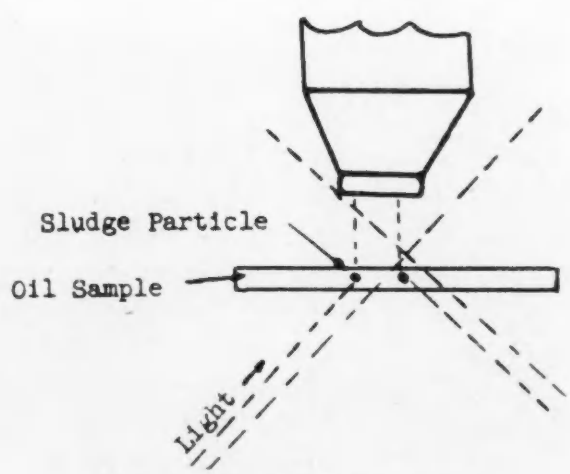


Fig. 6—Principle of dark-field microscope

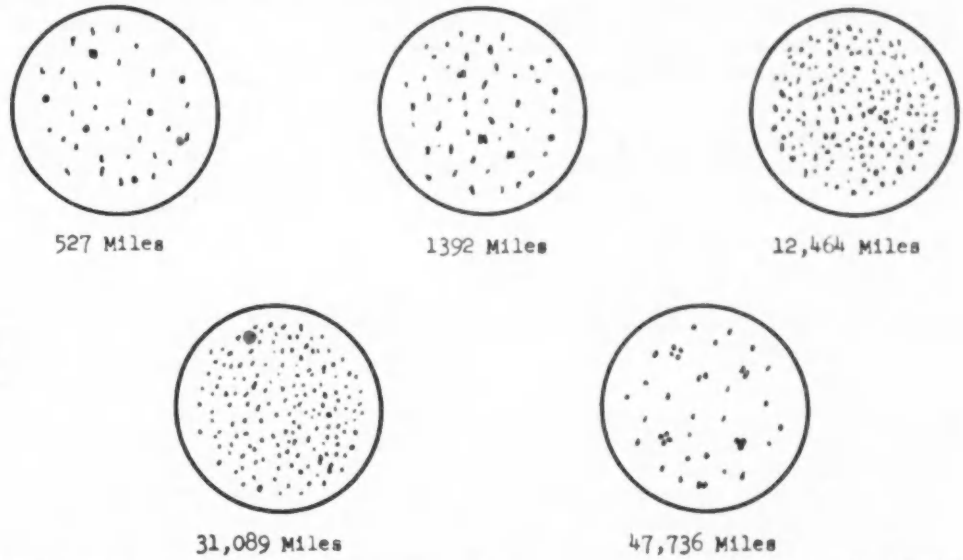


Fig. 7—Example of dark-field microscope inspections

in following dispersant properties of all types of oils.

Thus far, we have considered the depletion of effective dispersant. Apart from rather complicated chemical tests, the extent of oxidation cannot be estimated except roughly by the color of the outer spot of the blotter test: the darker the color the greater the oxidation; however, no precise method of determining the safe limit has been evolved.

Fig. 8 shows blotter spot tests of the oil samples used in Fig. 3. It is interesting to compare the oil analyses with the individual spots. The first three oil samples contained very little chloroform insolubles and the spots show only a small amount of black deposits. As the chloroform insolubles increased up to the spot at 43,000 miles the black portion of the spot became more dense.

In both instances, when the chloroform insolubles dropped rapidly, as indicated by the valleys in the curves in Fig. 3 at 55,000 to 94,000 miles, the oil spot shows considerably less black material than the previous spot. The oil remained less dispersant after 66,000 miles, as indicated by the smaller diameter of the black portions of the spots. Dispersancy was, however, still satisfactory at the end of the test. The oxidation products increased slightly during the test, as indicated by the change in the outer portion of the spot from yellow to light orange.

It was found that the ash content of the periodic

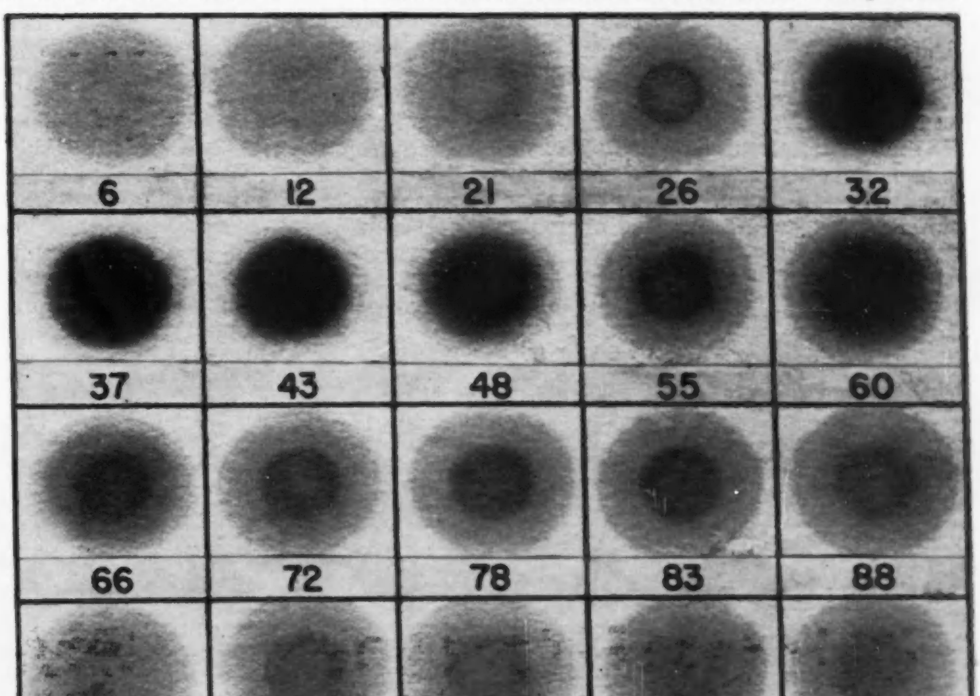


Fig. 8—Example of blotter spot results for 1500-hp freight engine with crankcase fortification (oil mileage in thousands)

Table 1—Lubrication Oil Costs for 1500-Hp Freight Engine —200-Gal Crankcase Capacity—12 Gal per 1000-Mile Oil Consumption—90,000 Miles of Service

	30,000-Mile Oil Change		
Three Oil Changes	600 gal at 50¢	$300.00	
Make-up Oil	1080 gal at 50¢	$540.00	
Total Cost			$840.00
	Crankcase Fortification		
One Oil Change	200 gal at 50¢	$100.00	
Make-up Oil	810 gal at 50¢	$405.00	
Fortification Agent	270 gal at 65¢	$175.00	
Total Cost			$680.50
Saving			$159.50
Saving (on % basis)			19

oil samples from the engines under test did not reach as high a percentage as expected. The ash content of the oil when new was 0.4%.

The ash content gradually increased to 0.6 or 0.7% during the first 35,000–45,000 miles. From that time on until the end of the test the ash content fluctuated within narrow limits near this percentage. No explanation for this condition has been developed.

Fig. 9 shows the effect of the crankcase fortification on additive effectiveness, which was determined by a chemical procedure found to be reliable for the type of oil used in these tests but that cannot be used universally. It correlates well with blotter spot tests and dark-field microscope inspections. The curves indicate that with the addition of additive according to the procedure followed, a safe level of effectiveness would be maintained indefinitely and regular oil changes would not be required. Blotter and dark-field microscope tests showed adequate dispersion during the entire period.

It is more economical, based solely on the cost of new lubricating oil, to operate high-output diesel engines for extended oil mileages with crankcase fortification than to change oil when the normal additives appear to become ineffective.

Table 1 shows the cost of lubricating oil required for a freight engine under normal lubricating practices with oil changed every 30,000 miles, as compared with the same engine on extended oil mileages and crankcase fortification. Costs are calculated for one year's operation of 90,000 miles. Approximately 12 gal of make-up oil is required per 1000 miles.

Lubrication with fortification eliminates at least two oil drains per year per engine, as shown in Table 1. The oil recovered from an oil drain averages 175 gal, which indicates a reduction of 350 gal of crankcase drainings per year per engine.

By lubricating the fleet of 50 high-output freight engines with fortification of crankcases, it is expected that there will be a reduction of new lubricating oil costs of approximately $8000 per year, and a reduction in the accumulation of crankcase drainings of about 17,500 gal per year.

The fortification method appears to be adequate but requires the purchase of an extra petroleum product and special handling by the terminal forces. It seems that it would be desirable if the oil suppliers could furnish an oil with additives that would remain effective for extended mileages and thus would eliminate the necessity of periodic drains or fortification of the crankcase oil.

If improved additives are not available it may be possible to secure extended oil mileages by increasing the amount of the additive contained in the new oil, so that the total amount of additive supplied to the crankcase over a given period would equal the amount of additive supplied by the fortification procedure.

Inasmuch as make-up oil is usually added every 500–1000 miles, the concentration of effective additive in the crankcase should remain more constant when high additive oil is used than when a large amount of additive is added at each 5000-mile filter change.

Therefore, high-output freight diesel engines in heavy freight service probably could be lubricated satisfactorily for extended mileages with the present heavy-duty oils available if the additive content of the oils were increased. It is doubtful that the advantages of higher additive oils in high-output railway diesel engines could be determined by the usual 100-hr or 500-hr laboratory engine tests. It is believed that these tests are comparable to no more than 25,000–30,000 miles of heavy freight service.

It is believed that the use of higher additive oil offers sufficient promise of being able to operate with extended oil mileages to merit a full-scale field test to determine the results that could be obtained.

(Papers on which this abridgment is based are available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

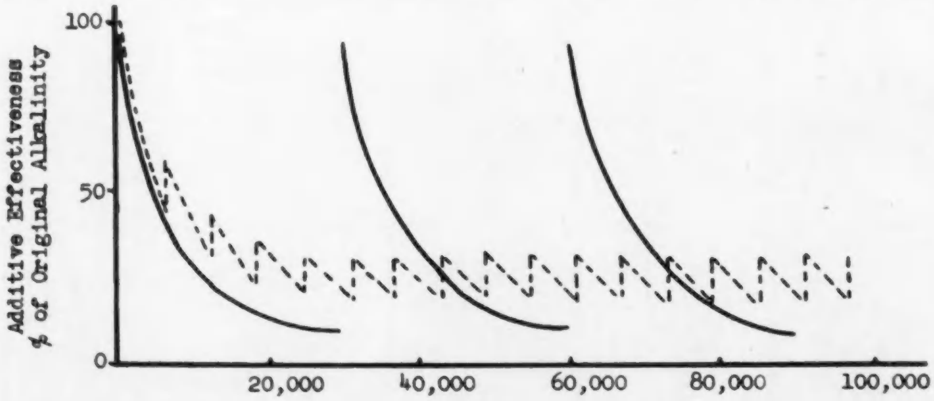


Fig. 9—Typical curves showing variation of alkalinity
—— 30,000-mile drain periods
- - - No drain but addition of 15 gal of concentrate at 6000-mile intervals

Hydrodynamic Drive Terminology

SAE Recommended Practice

SINCE the torque converter and fluid coupling have become a commonly used component of automatic transmissions in American industry, the SAE appointed a committee to standardize terminology, test procedure, data recording, design symbols, and so forth, in this field. The following committee recommendations will facilitate a clear understanding for engineering discussions, comparisons, and the preparation of technical papers.

Practice in industry at present is not uniform. The recommended usages represent the predominating practice or the acceptable practice. Where agreement is not complete, alternates have been included for clarification. For example, three systems of blade-angle designations are described. Consequently when a blade angle is specified, the system should be designated.

This SAE Recommended Practice* deals only with the physical parts and dimensions and does not attempt to standardize the design considerations, such as the actual fluid-flow angle resulting from the physical blade shape.

HYDRODYNAMIC DRIVE, as contrasted with electrical or mechanical, and so forth, is the type of drive that transmits power solely by dynamic fluid action in a closed recirculating path.

FLUID COUPLING is a hydrodynamic drive which transmits power without ability to change torque. (Torque ratio is unity for all speed ratios.) See Fig. 1.

TORQUE CONVERTER is a hydrodynamic drive which transmits power with ability to change torque. (Torque ratio is a function of speed ratio.) See Figs. 2-5.

STAGE (single-stage, two-stage, three-stage) applied to a torque converter refers to the number of driven members separated from each other by members of different function such as stators or input members. See Figs. 2 and 3.

PHASE (single-phase, two-phase, polyphase) applied to a torque converter refers to the number of functional arrangements of the working members when the functional change is by mechanical means; for example, a stator which may freewheel in one direction. See Figs. 4 and 5.

MEMBER refers to a functional component of the hydrodynamic drive such as a pump, turbine, or stator.

PUMP or impeller designates the power-input member.

TURBINE designates the output member.

STATOR or REACTOR designates the reaction member.

NOMENCLATURE OF MULTIPLE MEMBERS of basically the same function in both polyphase and multistage torque converters should be named in the order of fluid circulation in normal operation.

1st pump	1st turbine	1st stator
2nd pump	2nd turbine	2nd stator
and so forth	and so forth	and so forth

BLADE designates the element of a member upon

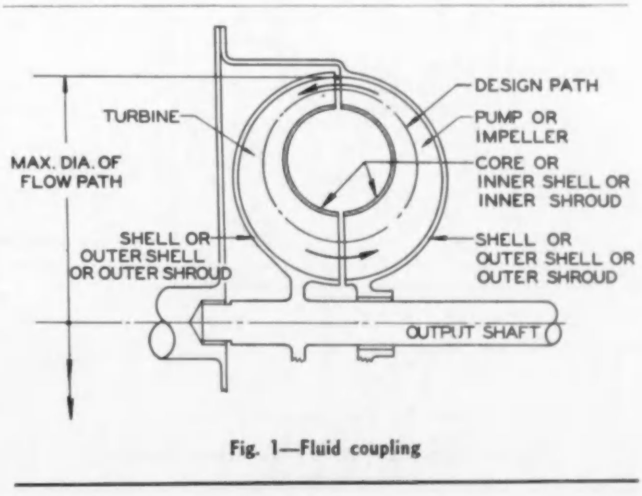


Fig. 1—Fluid coupling

* This report of the SAE Hydrodynamic Drive Technical Committee will be published in the 1951 SAE Handbook. It will also be available in booklet form as SP-78, for 50¢ a copy to SAE members and $1.00 a copy to nonmembers from SAE Special Publications Department, 29 West 39th Street, New York 18, N. Y. Quantity prices may be had on request.

which the fluid exerts working force.

SHELL, OUTER SHELL, or OUTER SHROUD designates the outside wall of the toric fluid path in any member. See Figs. 1 and 2.

CORE, INNER SHELL, or INNER SHROUD designates the inside wall of the toric fluid path in any member. See Figs. 1 and 2.

DESIGN PATH is the path of the assumed mean effective flow and is used for definition of blade angles, entrance and exit radii, and so forth. See Figs. 1–6.

BIAS (entrance and exit) designates the angular discrepancy at the entering and leaving edges of the blades, where the full length of the entering and leaving edges of the blades are not in an axial plane (contains the axis of rotation). See Fig. 6.

SCROLL is the angle between the two planes containing the intersection of the design path and the entering and leaving edges of the blade when that blade does not lie in one axial plane. See Fig. 6.

TORQUE CONVERTER SIZE in general terms is designated by the maximum diameter in inches of the flow path. See Fig. 1.

DESIGN RADII (entrance or exit) of any member are taken at the point of intersection of the design path with the theoretical blade edges. See Fig. 6.

SPEED RATIO designates the output speed divided by the input speed.

TORQUE RATIO designates the output torque divided by the input torque.

STALL TORQUE RATIO designates the torque ratio with a stalled turbine.

STALL SPEED designates the input speed in rpm with a stalled turbine at a specified input torque.

RACING SPEED designates the input speed in rpm with a free turbine at a specified input torque.

TORQUE CONVERSION RANGE designates the range of operation where torque multiplication exists.

COUPLING RANGE designates the range of operation at 1 to 1 torque ratio.

COUPLING POINT designates the point where the torque conversion range ends and the coupling range begins.

CHARGING PRESSURE designates the externally applied pressure under which the converter operates.

BLADE ANGLES are the angles formed by the geometry of a blade at its entrance and exit edges. Unless otherwise mentioned, these angles are measured from a tangent to a point on the design path surface. When a blade angle is not constant across the width of a blade, specific mention must be made of the manner of variation.

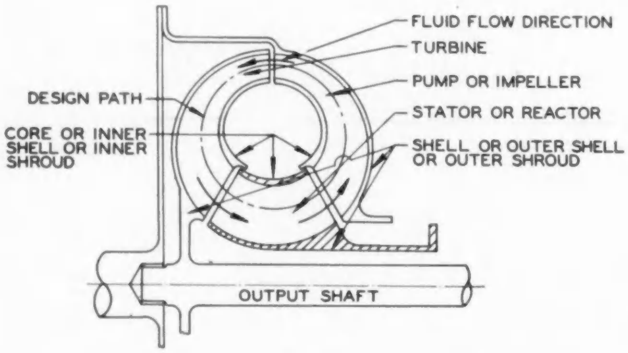


Fig. 2—Single-phase, single-stage torque converter

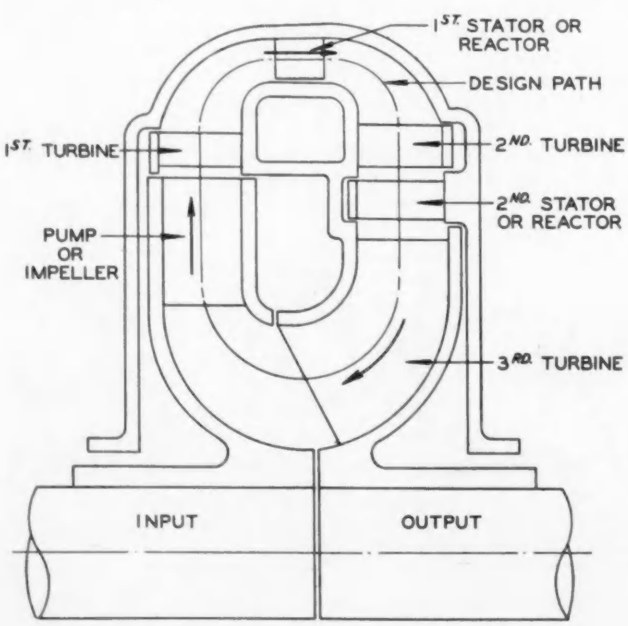


Fig. 3—Single-phase, three-stage torque converter

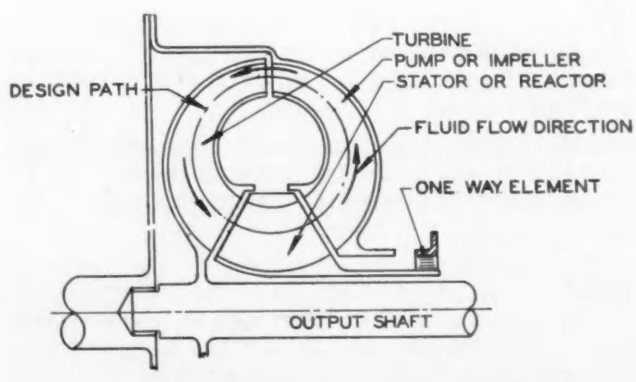


Fig. 4—Three-member, two-phase torque converter

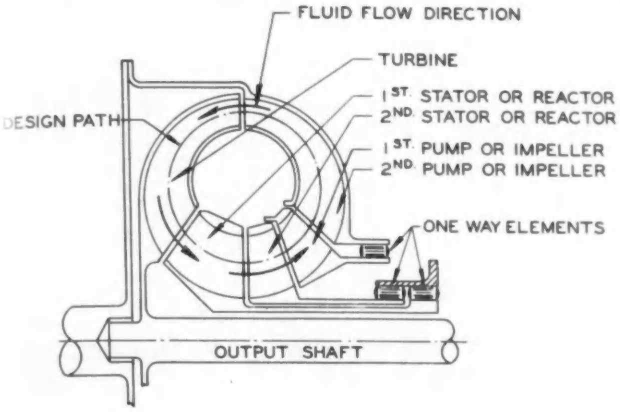


Fig. 5—Five-member polyphase torque converter

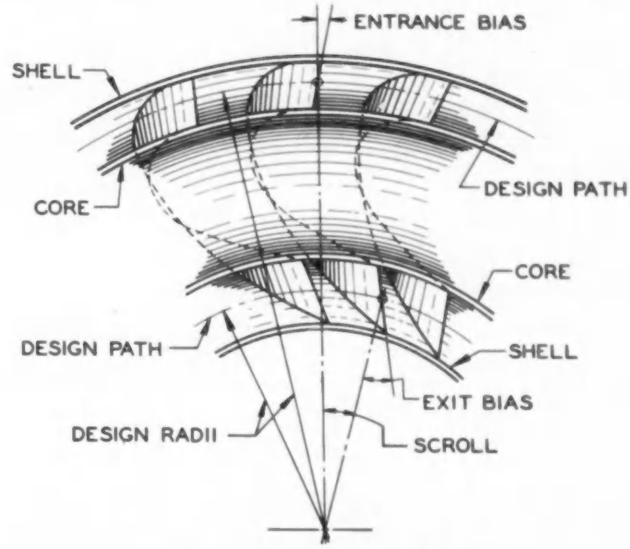


Fig. 6—Blade terminology (turbine)

MEAN CAMBERLINE of a blade profile, taken at the intersection of the design path surface, is the locus of the centers of the series of circles which are simultaneously tangent to both surfaces of the blade profile. See Fig. 7. This method of mean camberline determination is shown for a continuously varying double-surface type of hydrofoil. The same system is to be used for all other types of blade profiles, including cases where discontinuities arise, because of edge modifications, as with sheet-metal blades.

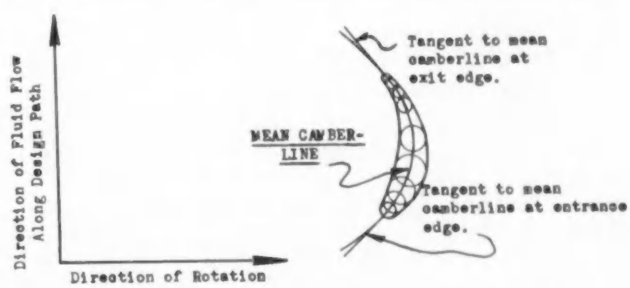


Fig. 7—Developed section of blade at intersection with design path surface

ENTRANCE ANGLES and EXIT ANGLES are measured as the angles between the respective tangents to the mean camberline of the blade and a plane perpendicular to, or parallel with, the plane of rotation (depending on the system of measurement used—that is, System A, or Systems B and C, respectively, as hereafter described).

BLADE-ANGLE SYSTEMS are the systems used for systematically and consistently describing blade angles. There are three currently used blade-angle systems. See Fig. 8.

System A takes zero blade angles to have no backward or forward bend: That is, all angles are measured from a plane of reference which passes through the axis of rotation. Blade angles which have a component in the direction of rotation are taken as positive. Blade angles which have a component opposite to the direction of rotation are taken as negative. Trigonometric functions of their angles, as used in torque-converter design, derive their plus or minus sign from the above rules.

System B takes zero blade angles to have the maximum possible forward bend angle in the pump: That is, all angles are measured from a plane of reference, which is the plane of rotation. All blade angles are positive. Trigonometric functions of these angles, as used in torque-converter design, derive their plus or minus sign from the trigonometric tables in their proper quadrants.

System C takes zero angle as the maximum possible back bend on the pump. This system is the exact reverse of System B.

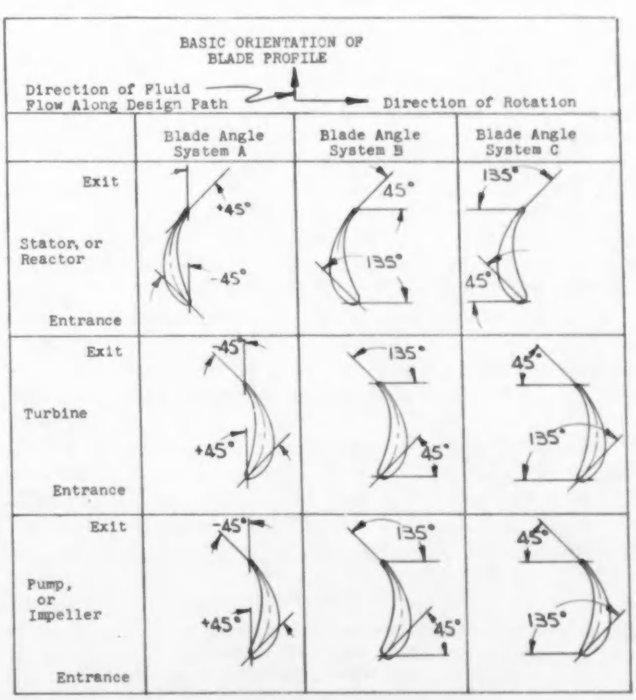


Fig. 8—Blade-angle systems

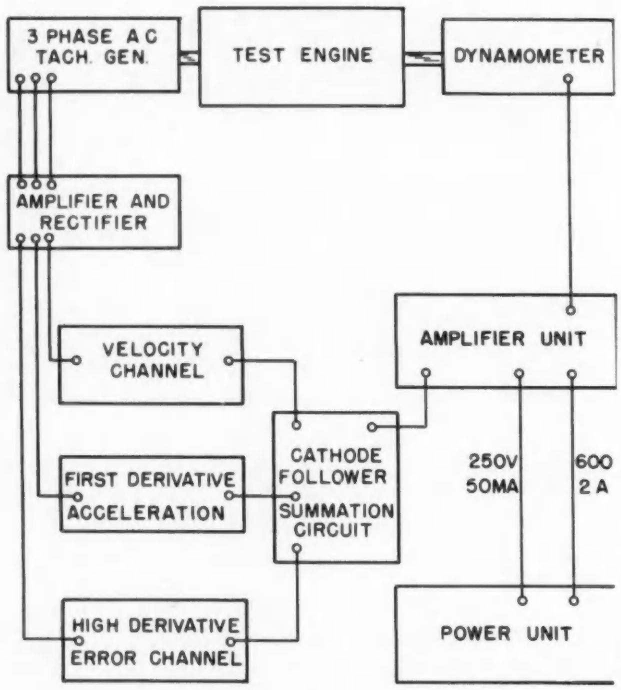


Fig. 1—Block diagram

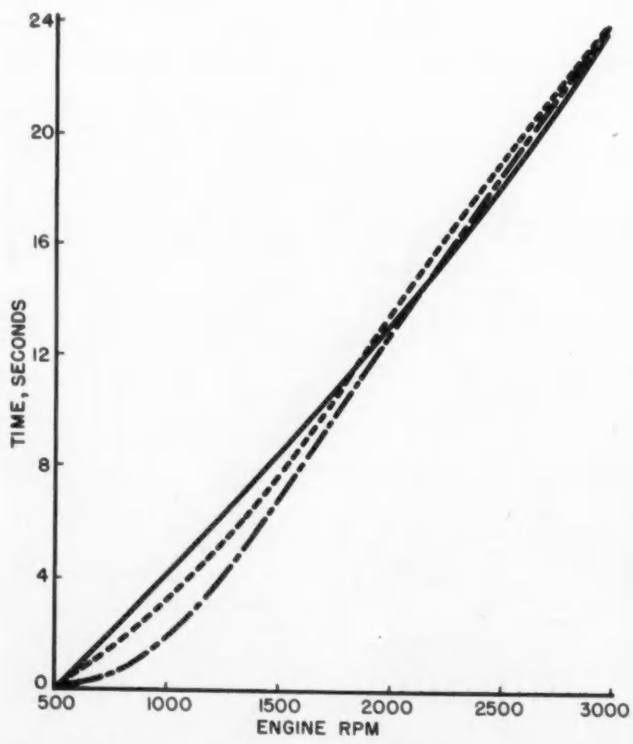


Fig. 2—Full-throttle acceleration characteristics
——— Road tests—1946 Chevrolet
—-— Acceleration control—original design
- - - - - - Acceleration control—final design

Road-Type

A NEW electronic control that imposes a dynamometer load on a laboratory engine to simulate road operation promises to speed up fuel testing, lower its cost, and reduce atmospheric and other uncontrollable factors. Comparative tests for antiknock quality and engine deposits and wear showed that results obtained in the laboratory with the electronic control agreed closely with data derived from actual road tests with a car.

Although developed primarily to obtain road-type fuel ratings under full-throttle acceleration, the control is equally useful for rating fuel under any other conditions. For the study of deposits and wear, it can be used in conjunction with a cycling throttle control to simulate stop-and-go driving or any other cycle of operation.

Description

In high-gear, level-road car operation, the engine at any one speed is subject to both a constant and a variable load. The constant load comprises the rolling plus the air resistances of the car. The variable load is the inertia of the car. The difference between the engine power available and the constant resistance is the maximum power available for acceleration. The general shape of performance curves is the same for all vehicles, but their absolute values depend primarily on engine power and car weight. The rolling plus air resistance curve (which is available in numerous references and from car manufacturers' data) must therefore be duplicated, in form, by the dynamometer control. Adjustment must also be provided to vary the end value of this curve to account for variations in engine power and car weight.

Fig. 1 shows a block diagram of the electronic solution for this control. Essentially, it is a closed servo system in which a speed-sensitive tachometer generator on the test engine shaft provides a signal

BASED ON PAPER* BY

A. R. Isitt, M. R. Wall, and A. G. Cattaneo

Shell Development Co.

* Paper, "Engine Dynamometer Control for Fuel Evaluation by Simulated Road Tests," was presented at the SAE National Fuels & Lubricants Meeting, Tulsa, Okla., Nov. 9, 1950.

Fuel Rating Obtained in Laboratory

to the control circuit and from there to the amplifier, which supplies field current for the dynamometer to load the test engine. Since the load on a car at any instant during acceleration is a summation of velocity or resistance load plus acceleration or inertia load, the control similarly has a velocity and an acceleration channel. These channels plus a third "error" channel are similar in design.

In the development of the control, a full-throttle speed-time curve was first obtained for a 1946 Chevrolet standard coupe on the road, using an Esterline Angus recorder actuated by an a-c tachometer generator. A duplication of this curve was then attemped in the laboratory by proper design of the velocity and inertia channels in the dynamometer control.

Fig. 2 shows some curves obtained with the recorder during the development of the dynamometer control, compared with the original road curve. The accuracy of the duplication and the reproducibility of the control appear satisfactory except at the extreme low-speed end, where the high inductance of the dynamometer field precludes rapid enough loading of the engine to prevent overspeeding. It is evident that the mechanical inertia of the dynamometer rotor has little effect here, with its low polar moment of inertia.

The inability of the original version of the control to hold the engine speed down at the low-speed end because of the high inductance of the dynamometer is apparent from Fig. 2. The dotted curve was obtained with the final design and shows a closer agreement with the road curve at the critical end.

All three channels are provided with independent adjustments with sufficient range to handle any make of automobile and any size of dynamometer.

In general, velocity loading affects the high-speed end and acceleration loading affects the low-speed end of the curve. Once these adjustments have been made, the engine under ELR control can be operated by its throttle alone, and will respond as it would in a car in high gear on a level road. Idling, acceleration at part or full throttle, cruising at constant speed, and various rates of deceleration are obtained as a fully automatic response to throttle manipulation.

Operation on a constant grade can be simulated by a suitable increase of the velocity component.

Knock Tests

Comparison of both the Modified Uniontown and the Borderline Test Methods results as obtained on the road and in the laboratory using the ERL control showed them to agree quite closely. These tests were run on a 1942 Chevrolet engine with reference fuels isooctane and normal heptane and five fuels made up from straight-run, thermally cracked, and catalytically cracked components. Each fuel was tested unleaded and with 1.5 cc tel per gal. These fuels had a wide enough variation in sensitivity to establish the differences in multicylinder octane ratings under constant-speed and accelerating conditions.

The laboratory data were obtained in an engine of the same make and year as that used in the road tests.

Fig. 3 shows ERL road octane ratings for the most sensitive fuel at various speeds, obtained by superimposing the test fuel curves on the reference fuel framework. The sensitivity, that is, the difference between Motor Method and Research Method octane numbers was 10.3 for this fuel unleaded and 12.8 leaded, which indicates that this fuel would show the greatest response to engine operating severity. The agreement between the road octane curves and those from the laboratory is reasonably good if the experimental error usually present in Borderline testing on the road is taken into account. The other

fuels tested showed the same trends and in general better agreement.

The reproducibility between runs in the laboratory using the ERL dynamometer control was better than that obtained on the road. Certain ramifications of this type of test make for poor reproducibility and repeatability, particularly the factor of extraneous noises, which are still present in the laboratory but, perhaps, in a different form than on the road. The Chevrolet engine in the laboratory produces a ping-like noise under nondetonating conditions, which greatly interferes with the establishment of Borderline knock. Insulation of the engine to reduce this interference is of definite help

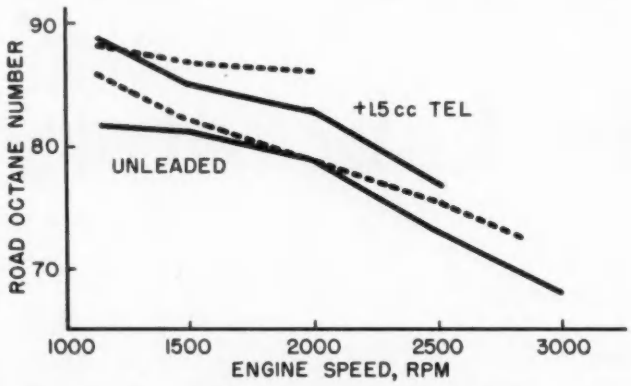


Fig. 3—Road octane numbers for most sensitive fuel tested
——— Road tests
- - - - - - - Laboratory tests

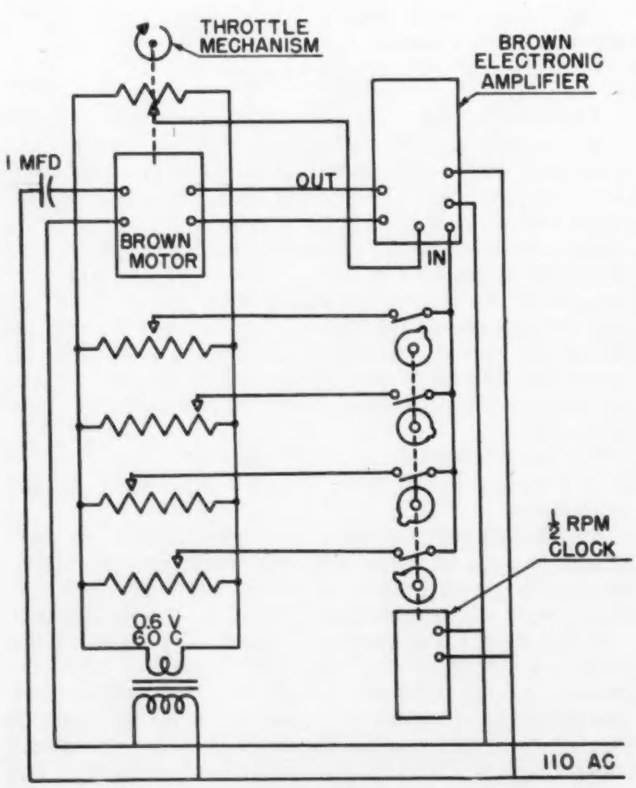


Fig. 4—Throttle program controller block diagram

and use of detonation indicators of the electronic type promises to overcome the difficulty entirely. In the meantime, the electronic road-load dynamometer acceleration control plus aural detection of knock afford, relative to road tests, greater ease of control, a better order of reproducibility, and require less time for the tests to be made.

The ERL control can also be used, with the aid of an automatic throttle control, to provide any cycle of operation for studies of engine deposits and wear. Since the ERL control automatically applies a road load corresponding to a given throttle setting, or change in throttle setting, it permits the use of a relatively simple throttle program timer to duplicate any desired operating cycle.

As an example of the device applied in this fashion, it was desired to operate a laboratory engine in a manner typical of city driving. Consequently, a device for activating the throttle in accordance with a predetermined program was constructed.

To obtain a record of throttle action during city driving, a Chevrolet car was fitted with a throttle position recorder and numerous records were obtained over a five-mile test course used in the investigation of city-type wear and sludge formation. The records indicated the actual throttle opening and time between openings corresponding to the change in operation accompanying gear shifting. Many of these records were averaged and a device developed to reproduce this average pattern on a laboratory engine.

The throttle program controller so developed consists of a standard Haydon program timer with four adjustable cams driven by a ½-rpm clock motor, which gives a 2-min recycling program. The desired time interval for each element of the throttle sequence is set on the appropriate adjustable cam, which operates a miscroswitch. The amplitude of each program element is handled by a self-positioning electronic servo system in which a Brown Electronik amplifier, from a potentiometer recording instrument, drives a Brown pen motor connected to the throttle mechanism. The switch selects one of four variable resistances, which is preset to the desired amplitude and the motor runs until the variable resistance on the motor shaft reaches the same amplitude. There is a finite time required for the throttle positioning motor to find the new position and a compromise exists between the size of the motor and the speed of operation. The Brown pen motor can make a full throttle change in about 1 sec. A block diagram of the throttle program controller is shown in Fig. 4.

While an exact duplication of the road throttle position record was not obtained, the approach was close and was felt suitable for the purpose. Close correlation between wear and deposit data obtained on the road and in the laboratory was obtained. By variation of the cam actions and speed of the drive motor, other programs can, of course, be set up. Simpler mechanisms can certainly be visualized and since they involve only manipulation of the throttle, the system becomes particularly attractive.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

THOUSANDS of SAE members are working actively on administrative and technical committees. These are the groups through which the Society does its work—and gets its results.

They run the meetings, guide the publications, get out standards and technical committee reports, operate the Sections. They are living testimony to the truth that SAE is the product of its members' efforts.

At the 1951 Annual Meeting alone some 84 committee meetings sped forward the Society's administrative and technical work.

For SAE Journal, Eleanor Allen's inquiring camera caught just a few of these stalwarts in action around the Book-Cadillac during the week of January 8–12. . . . They are typical of SAE officers and committeemen busy doing a job for their fellow members.

G. A. Round, chairman, Fuels & Lubricants Subcommittee on Torque Converter Fluids

T. B. Rendel, chairman, Publication Committee

Left to right: V. E. Hense, Chairman H. W. Browall, and E. J. Tompkins, of the Carbon Steels Division of the Iron & Steel Technical Committee

Continued

V. J. Jandasek (left) and Chairman R. P. Lewis of the Hydrodynamic Drive Technical Committee

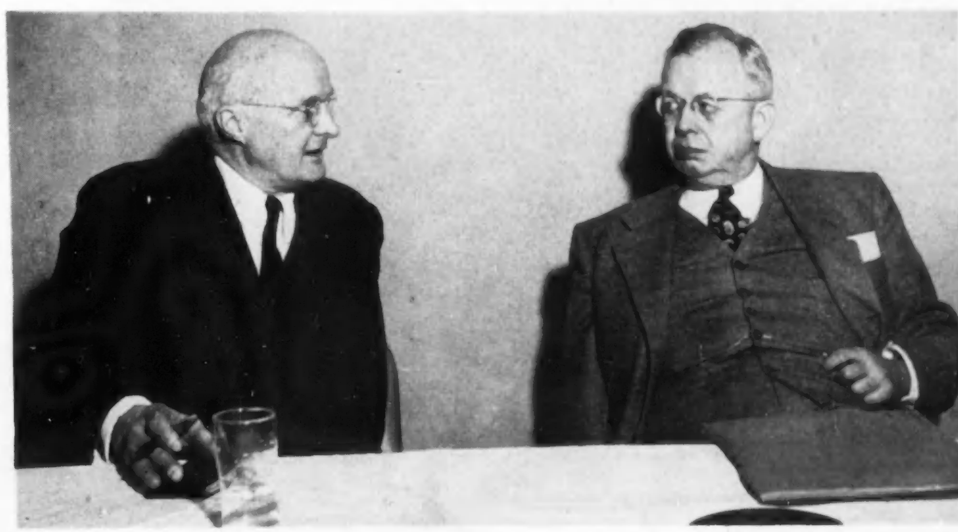
Harold S. White, chairman of the Engine Technical Committee

Chairman R. N. Janeway (left) and Robert Schilling of the Riding Comfort Research Committee

Left to right: E. O. Reynolds, Chairman R. K. Super, and T. P. Chase, Dynamometer Test Procedure Subcommittee of the Brake Committee

Continued

A. T. Colwell, chairman of the Finance Committee



W. S. James (left), 1950 chairman of the Student Committee and Robert Insley, 1951 chairman of the Sections Committee

J. H. Bolles, chairman, Electrical Equipment Technical Committee

E. J. Hergenroether, chairman, Review of Ordnance Specification Division of the Iron & Steel Technical Committee

Continued

Left to right: R. W. Sohl, consultant, L. S. Pfost, 1950 chairman, and L. A. Gilmer, Tractor Technical Committee

Chairman E. C. DeSmet (left) and Technical Board Sponsor A. G. Herreshoff, Passenger Car Body Technical Committee

Vice-Chairman J. H. Booth and Walter Lee of the Executive Committee of the Membership Committee. Mr. Booth presided at the committee's January 9 meeting in Chairman O. A. Brouer's absence

Left to right: S. G. Tilden, Chairman T. P. Chase, Stephen Johnson Jr., and Paul V. Brantingham of the Brake Committee

New Budd Diesel Railroad Car-Part II

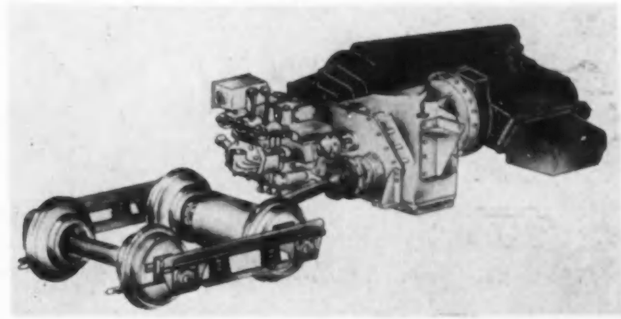


Fig. 1—Installation of transmission

The Torque Converter and the Transmission

BASED ON PAPER* BY

R. M. Schaefer, Allison Division, GMC

* Paper, "New Budd Diesel Railroad Car RDC-1 with Torque Converter Transmission—Torque Converter and Transmission," was presented at the SAE National Diesel-Engine Meeting, Chicago, Nov. 2, 1950. (Part I—"The New Budd Diesel Railroad Car"—appeared in the February 1951 issue of SAE Journal on pages 18 to 22.)

THE Budd railcar transmission—a hydraulic torque converter drive with mechanical reversing unit (see Figs. 1-3)—was designed to combine the low cost, light weight, and efficiency of the mechanical transmission with the smoothness and simplicity of the electrical transmissions.

The success of its designers in attaining low costs can be seen from Fig. 4, which is based on actual operating cost data. This graph shows that for the steam train, operating costs are \$1.71 per train-mile, for diesel-electric they are \$1.17 per train-mile, while for the diesel-hydraulic equipped car the costs are \$0.71 per train-mile. Thus, with the diesel-hydraulic drive the costs add up to only 41.5% of those for the steam train.

Fig. 5 compares the overall thermal efficiencies of the various engine-drive combination. This figure, which takes into consideration the thermal analyses of the power-plants themselves, shows that at 65 mph efficiencies are as follows: diesel-hydraulic: 24%; diesel-electric, 22%; straight electric, 17%; gas turbine-electric, 16%; Stearn electric-diesel, 10%; reciprocating steam, 6%.

Description

The transmission consists primarily of a 4-element single-stage GM torque converter with two sets of helical gears—forward and reverse—mounted on the converter main shaft and driving through a countershaft, which furnishes the output power to the railcar. The helical gears on the main shaft from the turbine output are engaged or disengaged to the power train, depending upon which speed is desired—forward or reverse—by multiple-disc clutches energized by oil pressure. Also, the torque converter has a lockup clutch built into the torus housing for the purpose of shifting the transmission from hydraulic to direct mechanical drive. (See Figs. 1 and 2.)

The torque converter itself consists of a pump, a turbine, and two stators, all cast in aluminum to very close tolerances by the plaster cast method. The pump is attached to the outer diameter of the engine flywheel so that these two members enclose the torque converter proper and become a rotating housing. The gear train does not furnish additional torque multiplication and merely is built into the transmission to provide forward and reverse for multiple operation and to allow proper distribution of the center of gravity of the engine with reference to the centerline of the railcar drive. Since the forward and reverse gear ratios are 1/1, two units may be used in one railcar—one driving through the forward gear train and the other through the reverse gear train.

Both input and output pumps are employed. The input pump is mounted on the transmission end cover and is driven by a shaft within the hollow drive shaft. This pump normally supplies the oil to the transmission. The output pump is car driven

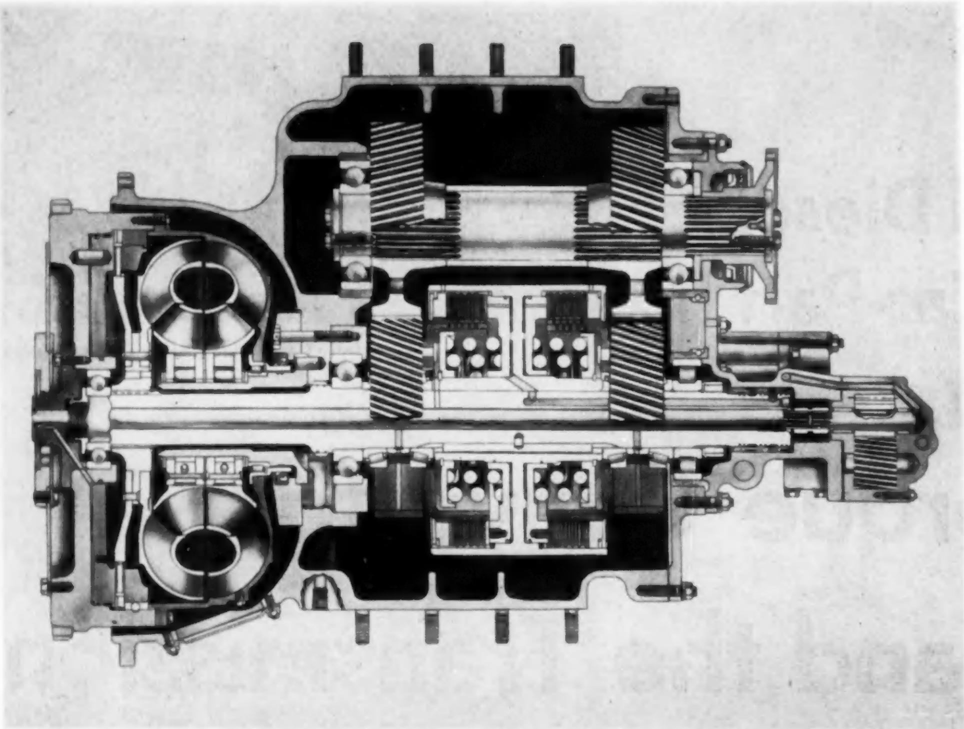


Fig. 2—Cross-sectional view of transmission

and, should the car be driven with only one engine and transmission, the nonoperating transmission receives pressure lubrication supplied by the output pump.

The valve mechanism has an upper and a lower group of valves. The regulator valves are in the lower group, while the control valves are in the upper group. The lower group has a clutch regulator, a converter regulator, and a lubricating oil regulator valve all controlled by springs. The upper group has three control valves—one for the lockup clutch, one for the reverse clutch, and one for the forward clutch. All three control valves are solenoid operated.

An accumulator valve communicates hydraulically with the three control and regulator valves to soften clutch engagement.

The lockup clutch governor is driven from a gear that meshes with the reverse driven gear on the countershaft. The speed of the governor, therefore, is determined by the speed of the transmission gear.

The purpose of the governor is to engage the lockup clutch automatically when the railcar has attained a predetermined speed, as well as to disengage the clutch at a certain decelerated speed of the car. The governor cuts in to engage the lockup clutch at 53-56 mph car speed and releases the clutch at 44-47 mph. The transmission is in direct drive when the lockup clutch is engaged, and in converter drive when the lockup clutch is disengaged.

Since the output pump and the input or engine-driven pump are connected in series and contain bypass valves, only the input pump is supplying the oil requirements of the transmission when the engine is operating.

Oil from the input pump, which normally supplies oil to the transmission, goes to the lower valve body, where it is regulated at 115-125 psi for the forward and reverse clutches by the spool-type pressure relief valve when in neutral or converter drive. Excess oil from this clutch valve is regulated in the torque converter circuit at 60-70 psi by the second spool-type valve. The bleed-off from the converter valve is regulated by the lubrication regulator valve in the lubrication circuit at 12-15 psi.

The lubrication circuit also receives oil that has passed through the torque converter and oil cooler.

When the transmission is shifted into either forward or reverse gear, the clutch pressure drops momentarily to approximately 50 psi and the accumulator valve outlet port closes.

After the clutch piston starts engagement of the multiple-disc clutch, the oil pressure rises and the

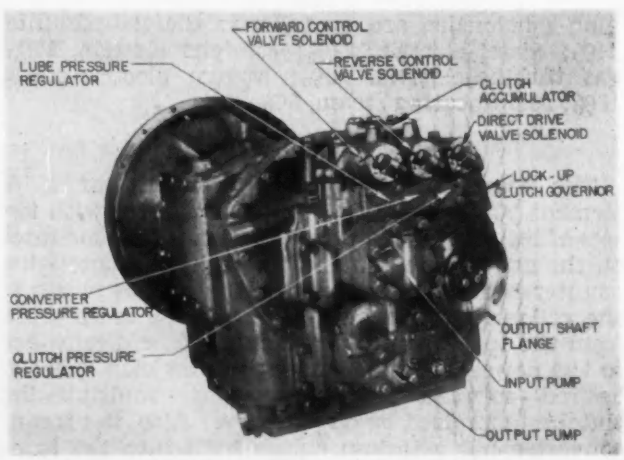


Fig. 3—External view of transmission

accumulator valve moves sufficiently to shut off the oil flow except for what can pass through metering holes in the valve. As the clutch engages, the accumulator valve continues to move back to its original position, which, together with the metering of oil, contributes to a softening of the engagement.

When the railcar attains a speed of approximately 55 mph, the governor makes an electrical contact and the lockup solenoid valve opens and oil is directed to the lockup (direct-drive) clutch. Also, at this time, oil is admitted to the clutch pressure regulator valves and the converter pressure regulator valve, which reduces the clutch pressure to 60-70 psi and the converter pressure to 30-35 psi. Although no pressure is required for the converter, as it is inoperative when locked up, this pressure produces oil flow through the oil cooler, providing cooled oil for lubrication. The decrease in oil pressure is permissible, as there is less torque on the clutches when in direct drive than when in converter drive, and with this lower pressure less work is required of the oil pump.

An oiling system common to the torque converter and the gear set is a feature of the railcar transmission. The capacity of the system, including the oil cooler and cooler lines, is 18 gal.

Performance

The transmission provides smooth application of power to the car driving axle by multiplying the torque or twisting effort of the engine. This is all accomplished without speed-stepped gears and without shifting from one speed ratio to another, either by hand or automatic control. The work of the starting clutch and the variable ratio transition from 3.6/1 torque multiplication for starting to 1/1 or lockup for full-speed running is performanced with oil, which requires no adjustments and is readily replaced after long service life.

Fig. 6 shows the transmission performance. Since the transmission is simply a hydraulic drive and since it is the means of converting engine torque to the required car performance, it becomes necessary to study the requirements of the railcar and the power performance of the engine before matching the engine to the converter.

There are many power-consuming factors in the operation of a railcar, such as wind resistance, rolling resistance, grade requirements, top speed, and acceleration rate, which must be taken into consideration when selecting the proper powerplant. At the same time, the method of transmitting the engine power to satisfy the railcar requirements must be kept in mind. In other words, the engine with its fixed speed-torque characteristics must be patterned to satisfy the car performance requirements. Thus, the torque converter was designed to match the GM 6-110 diesel engine, which had been selected to power the Budd railcar.

The performance curves show the output torque and horsepower plotted against the transmission output speed. These data may be used to study the car performance.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

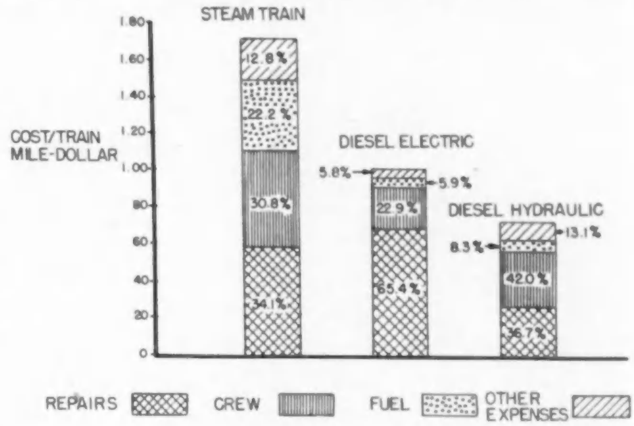


Fig. 4—Operating cost comparison

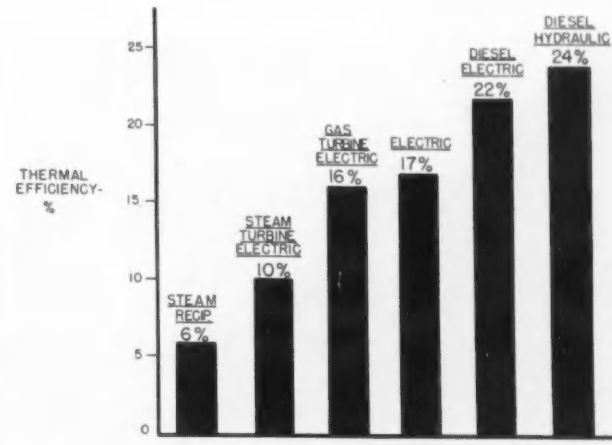


Fig. 5—Efficiency comparison

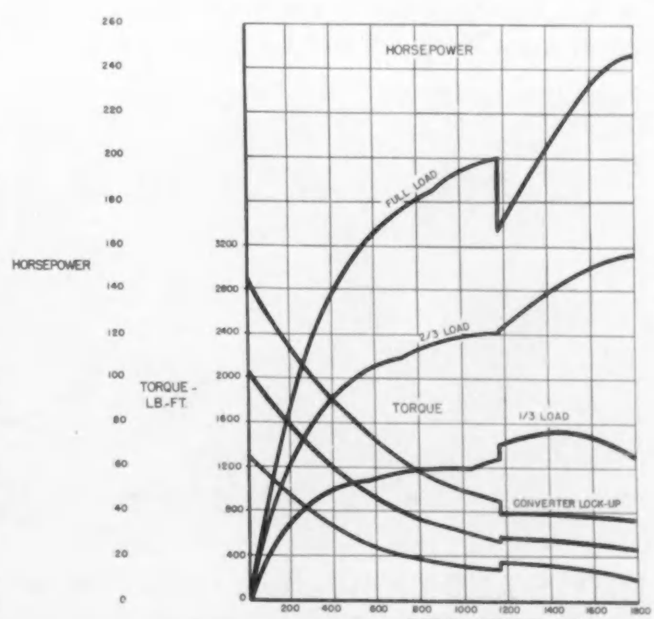
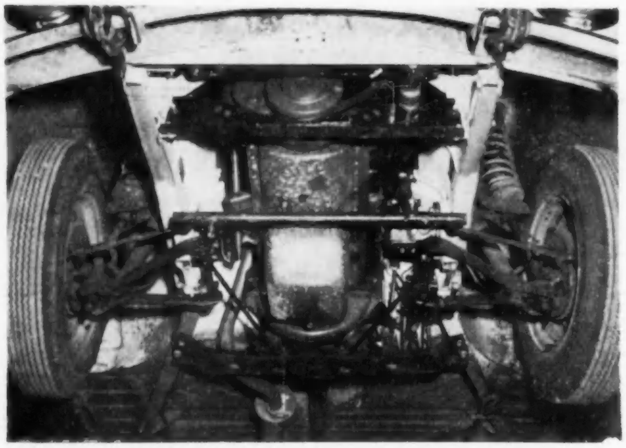
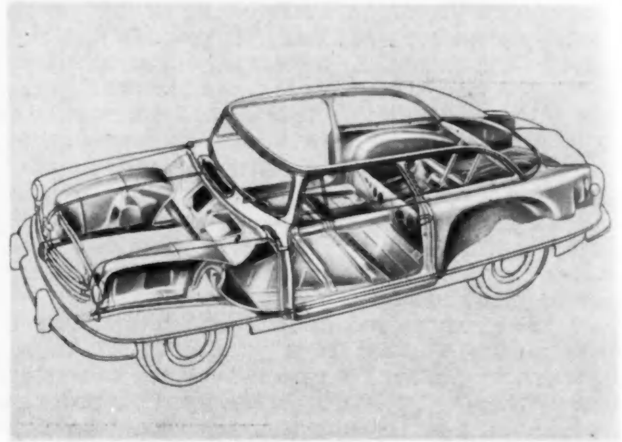


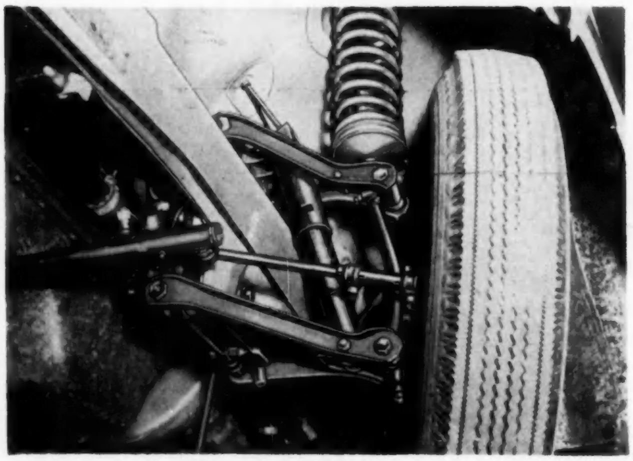
Fig. 6—Railcar transmission performance



ENGINE FRONT rests on a light cross mem- between the body sills, which is entirely independent of the front suspension.



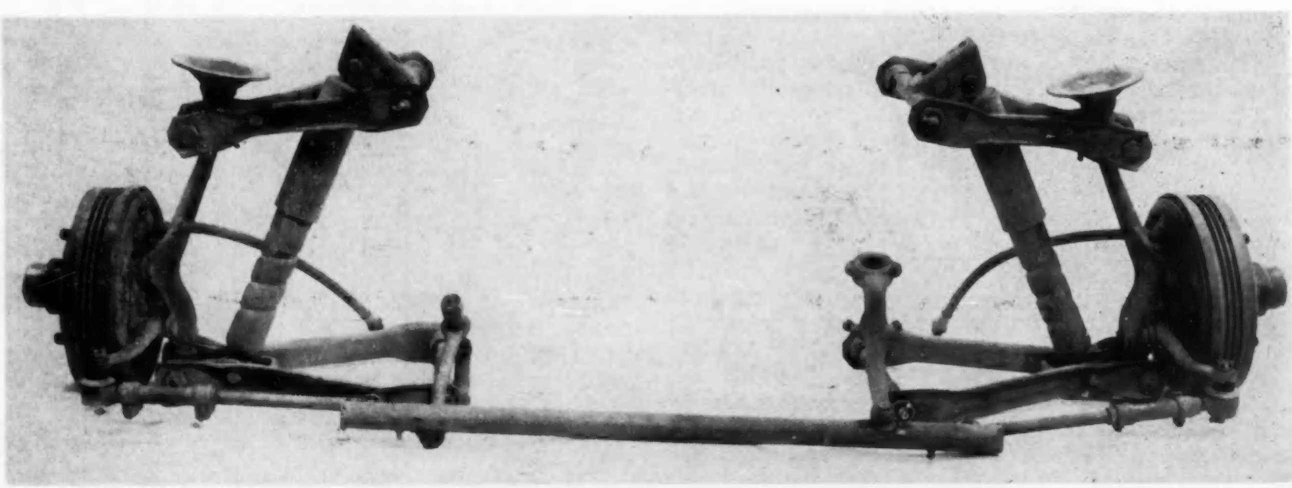
NASH AIRFLYTE CONSTRUCTION is used for the Rambler. Body forms major car structure, without need for separate frame.



FRONT SUSPENSION is attached directly to the body. Front springs are between top of steering knuckles and body structure.

Features of

The Rambler also is available in the Custom Station Wagon and Super Suburban models. Next model expected is a two-door sedan.



SIMPLE AND LIGHT front suspension is used for the Rambler. The suspension cross member is eliminated. Complete Rambler front suspension, including engine support, weights 74 lb, as compared with 187 lb in the Statesman.

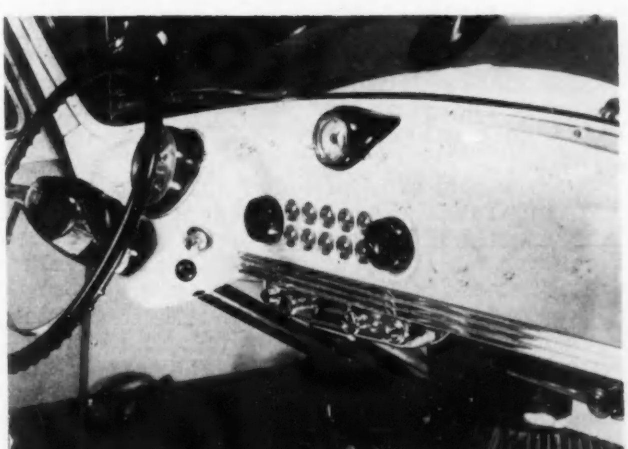
OVERHEAD RAILS, which are permanent, provide a girder-like body structure. They make unnecessary the usual cumbersome understructure of the ordinary convertible. They also prevent the flexibility and looseness of convertibles driving over rough roads.

Nash Rambler

BASED ON PAPER* BY

L. H. Nagler, Technical Advisor, Nash Motors Division, Nash Kelvinator Corp.

* Paper "Engineering Adventures in Light Cars," was presented at SAE So. Calif. Section, Los Angeles, Oct. 19, 1950. It is available in full in photolithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.



STEERING WHEEL is mounted flush with instrument panel. Gear shift and directional signal levers also are mounted on panel.

FRONT SEAT back is split off center so that three passengers may be more comfortably seated. The rear seat accommodates two.

SAE

Work

Three SAE technical groups are making recommendations to Ordnance about possible conservation of critical materials in the famous Army Jeep (M-38 Truck). The Jeep job was the first one attacked by these groups, set up to advise on critical materials conservation on tactical vehicles

SAE TECHNICAL COMMITTEES are swinging into defense activities at an ever accelerating pace. Follow-through on military assignments for Army ground-forces is reflected in greater numbers of participating committeemen as well as in growing size of projects.

With policy direction from the SAE Technical Board's Army Advisory Committee, many of the military projects are being handled by subcommittees of existing technical committees. Thus, defense operations have been speeded. Already-assembled technical talents have been applied to emergency needs.

Defense work on its way to completion includes projects on critical materials conservation, transmissions, Ordnance steels, earthmoving equipment, and other items.

Critical Materials in the Jeep

Working through three of its regular technical committees, SAE is well embarked on recommendations to Ordnance on conservation of critical materials in tactical vehicles. The Iron & Steel Technical Committee (E. H. Stilwill, Chrysler, chairman); the Non-Ferrous Metals Committee (W. E. Day, Jr., of Mack, chairman); and the Non-Metallic Materials Committee (W. M. Phillips of General Motors, chairman) each have subcommittees already at work.

The first project requested was to suggest possibilities for substitutions for critical materials in the Army Jeep (M-38 Truck). The three subcommittees working on this project are ISTC Division IV, headed by R. W. Roush of Timken-Detroit Axle; a subcommittee of the Non-Ferrous Metals Committee, headed by Joseph Gurski of Ford; and a subcommittee of the Non-Metallic Materials Committee, headed by A. J. Kearfott of General Motors.

The Non-Metallic Materials subcommittee on the Jeep took up first recommendations for conservation of both natural and synthetic rubber . . . . And the subcommittee of the Non-Ferrous Metals Committee is recommending conservation measures in its area.

In developing its recommendations on substitu-

Technical Committees Speed on All Defense Assignments

tion of ferrous metals, the Roush committee studied in detail more than 75 parts of the Jeep. Trying to effect maximum results, this Division IV based its final recommendations as eight basic rules:

1. All recommendations call for the lowest grade of material with respect to critical alloy content which is believed capable of giving satisfactory service.
2. No steel was specified that is believed to be better than needed to do the job.
3. Recommendations follow the plan of first using plain carbon steels as far as possible . . . secondly, of using as much low alloy steel as possible . . . and lastly, considering parts which require high alloys only.
4. Definite specifications are only for materials that are known to be satisfactory. Other materials of higher alloy content will be satisfactory per se.
5. All recommendations take into consideration processing methods and treatment.
6. All recommendations take into consideration availability of materials as far as can be determined.
7. Any steel for which experience data are not definite is recommended for use only after satisfactory proof testing.
8. All numbers on reports are SAE numbers unless otherwise specified.

Automatic versus Conventional Transmissions

Evaluating for the Army the whys and wherefores of automatic versus conventional transmissions in tactical vehicles is another military project which is developing rapidly. A special Transmission Committee, headed by Chrysler's E. P. Lamb, is aiming at recommendations as to possible use of automatic transmissions in tactical vehicles.

Serving with Lamb on this committe are: W. F. Benning, Willys-Overland; F. R. Nail, Mack Mfg.; C. J. Bock, GMC Truck & Coach; H. E. Churchill, Studebaker; H. K. Reinoehl, International Harvester; Dale Roeder, Ford, and W. M. Walworth, Reo.

Ordnance Steel Spec Evaluated

Nearing completion also is the project of a division of the Iron & Steel Technical Committee which is recommending revisions to Army Ordnance on a new steel specification. The new specification is intended greatly to facilitate substitutions required in wartime to meet changing conditions in the supply of critical alloys.

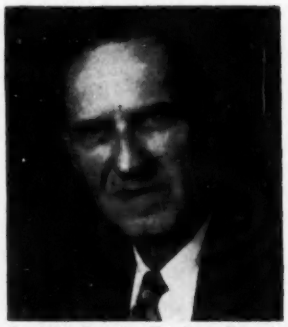
E. J. Hergenroether of International Nickel is chairman (see photograph on page 47 of this issue). The broad coverage of knowledge and opinion en-

S. W. Sparrow, Studebaker, is chairman of the SAE Technical Board

E. H. Stilwill of Chrysler is chairman of the Iron & Steel Technical Committee

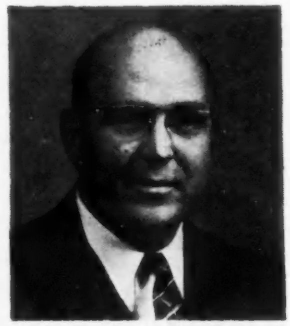
W. E. Day, Jr. of Mack Mfg. is chairman of the Non-Ferrous Metals Committee

W. M. Phillips, GMC, is chairman of the Non-Metallic Materials Committee



R. W. Roush, Timken-Detroit Axle, is chairman of the new Division IV (Critical Materials Conservation) of the ISTC

Joseph Gurski of Ford is chairman of a subcommittee of the Non-Ferrous Metals Committee on critical materials conservation



A. J. Kearfott, GM Research Laboratories, is chairman of a subcommittee of the Non-Metallic Materials Committee working on substitution of critical materials

compassed by this advisory group is indicated by its membership: M. L. Frey, chairman of ISTC, Allis-Chalmers; A. L. Boegehold, GM Research Laboratories; H. Bornstein, Deere; C. W. Briggs, Steel Founders' Society; H. W. Browall, Inland Steel; V. A. Crosby, Climax Molybdenum; L. A. Danse, General Motors; W. E. Day, Jr., Mack Mfg.; E. O. Dixon, Ladish Drop Forge; T. E. Eagan, Cooper-Bessemer; T. A. Frischman, Eaton Mfg.; J. H. Frye, Columbia Steel & Shafting; M. F. Garwood, Chrysler; Joseph Gurski, Ford; J. R. Gustafson, Ford; W. J. Harris, Studebaker; S. Reed Hedges, Minneapolis-Moline; V. E. Hense, Buick; E. L. Hollady, Ordnance; A. E. Jones, Watertown Arsenal; George Kalon, Detroit Arsenal; H. B. Knowlton, International Harvester; M. N. Landis, LaSalle Steel; G. C. Riegel, Caterpillar; R. W. Roush, Timken-Detroit Axle; L. E. Simon, Electro-Motive; E. H. Stilwill, Chrysler; E. J. Tompkins, Central Steel & Wire; Gosta Vennerholm, Ford; R. W. White, Ordnance; William Wiers, Fisher Body; P. R. Wray, Carnegie-Illinois Steel; F. P. Zimmerli, Barnes-Gibson-Raymond.

Army Views CIMTC Work

For more than a year now the Corps of Engineers of the U. S. Army has been following with interest the civilian work of the Construction and Industrial Machinery Technical Committee and its various subcommittees. (CIMTC Chairman is E. F. Norelius of Allis-Chalmers.) Liaison representatives of the Corps of Engineers have been attending practically all CIMTC steering committee meetings. Two CIMTC subcommittees — one on Hydraulic Power Controls, the other on Electrical Equipment—have held meetings at Camp Belvoir, Md. The CIMTC steering committee itself expects to hold a meeting at Belvoir next May.

A sealed-unit light, developed by the Electrical subcommittee, of which International Harvester's P. P. Polko is chairman, was approved and adopted by the Corps of Engineers about two months ago. The light is a floodlight for lighting a working area. A similar sealed-unit for a headlight and another for a spotlight are scheduled for development by this subcommittee.

The Corps of Engineers has been following with interest also the work of the CIMTC subcommittee on Standardization of Drawbars and Mounting Equipment for Industrial Tractors. J. E. Jass of Caterpillar is chairman of this subcommittee. At a meeting called by the Corps of Engineers in Chicago recently, and attended by members of the Jass subcommittee, initial steps were taken by the Corps to write into Engineers Corps specifications as much as possible of the standards developed by this committee to attain interchangeability of cable control units, heavy-duty winches, hydraulic pumps, front

able units and bulldozers from one tractor unit to another.

Personnel of these three subcommittees of the CIMTC are as follows:

Electrical Equipment Subcommittee: P. P. Polko, International Harvester, chairman; W. C. Geiser, Allis-Chalmers; R. F. Klatt, Euclid Road Machinery; E. B. Lanman, Bucyrus-Erie; R. O. McSherry, Oliver; C. H. Morris, Chrysler; J. Richter, Wooldridge Mfg.; and Randall Roman, Caterpillar.

Standardization of Drawbars and Tractor Equipment Mounting Subcommittee: J. E. Jass, Caterpillar, chairman; H. W. Brock, Oliver; A. C. Evans, Gar Wood; H. A. Land, International Harvester; G. W. Mork, Bucyrus-Erie; G. J. Storatz, Heil Co.

Hydraulic Power Controls Subcommittee: E. C. Iverson, Towmotor Corp., chairman; E. C. Brown, Austin-Western Co.; A. C. Evans, Gar Wood; J. A. Frischmann, Towmotor Corp.; W. W. Henning, International Harvester; J. E. Jass, Caterpillar; R. H. Lindberg, Isaacson Iron Works; C. H. Morris, Chrysler; G. A. Rea, Heil Co.; G. Reuter, Bucyrus-Erie; H. C. Schindler, Euclid Road Machinery; S. R. Skellenger, Clark Equipment; H. H. Washbond, Baker Mfg.; and A. G. Weston, Frank G. Hough, Co.

Civilian Conservation Projects

SAE has just answered "Yes" to a question generated by an inquiry from G. S. Peppiatt of Federal-Mogul, a member of the Automotive Replacement Parts Manufacturers Industry Advisory Committee to the National Production Administration. The question: "Does the problem of conservation of critical materials for automotive parts have any technical aspects which could be handled by cooperative action under SAE auspices?"

It is planned to handle specific projects which may be requested through existing SAE technical committees.

This NPA advisory project follows an exploratory conference organized for the Technical Board by Past-Board Chairman, W. S. Graves about the middle of January. Vincent C. Young of Eaton Mfg. presided at the exploratory session.

Individuals at the conference were: Vincent Young, chairman, Eaton Mfg.; Oliver Baker, Automobile Manufacturer's Association; J. H. Bolles, Delco-Remy; C. G. Davey, AC Spark Plug; Ray Hess, American Society for Testing Materials; Joseph Gurski, Ford; T. A. McAninch, Warner Automotive Parts; G. S. Peppiatt, Federal-Mogul; R. C. Sackett, SAE; E. H. Stilwill, Dodge; A. B. Willi, Jr., Federal-Mogul; Hale Zeder, Chrysler; C. E. Zwahl, Chevrolet.

E. P. Lamb, Chrysler, is chairman of the Transmission Committee which is advising Army Ordnance

Ordnance Cold Tests Observed

Another cooperation-with-the-military project nearing completion is participation by more than 25 SAE-designated engineers as observers in the cold weather tests of military automotive equipment at Camp Grafton, near Devil's Lake, North Dakota. The SAE observers went in relays at the invitation of Army Ordnance. The first group attended during the week of January 14 and succeeding groups were in attendance throughout the next few weeks. Among the SAE observers were: H. H. Bidwell, Allis-Chalmers; L. L. Cross, Brockway; E. B. Lanman, Bucyrus-Erie; A. J. Roualet, Chrysler; E. C. Sintz, Cadillac; J. W. Kinnucan, Continental Motors; W. C. Edwards, Delco-Remy; C. D. Christie, Eaton Mfg.; G. W. Lewis, Electric Auto-Lite; H. F. Copp, Ford; T. J. Radlet, Four-Wheel Drive; J. Gardner Lewis. GMC Truck & Coach; L. D. Gilmore, Heil Co.; M. J. Kittler, Holley Carburetor; W. H. Bechman and Julius Moravec, International Harvester; John Thomas, Mack Mfg.; S. E. Rowe, Marmon-Herrington; D. L. Raymond, Perfection Stove; Karl Maier, Reo; D. L. Davis, Studebaker; A. L. Pomeroy, Thompson Products; W. J. Kovelan, White; H. W. Klas, Willys-Overland; Walter Rheault, Young Radiator, and Palmer Orr, Warner Gear.

E. F. Norelius of Allis-Chalmers is chairman of the Construction & Industrial Machinery Technical Committee

P. P. Polko, International Harvester, is chairman of the Electrical Equipment Subcommittee of the CIMTC

J. E. Jass, Caterpillar, is chairman of the CIMTC subcommittee on Standardization of Drawbars and Tractor Equipment Mountings

R. C. Iverson of Towmotor is chairman of the subcommittee on Hydraulic Controls of the CIMTC

TRAFFIC SAFETY
And the World

The Fourth SAE
DAVID BEECROFT
Memorial Lecture
January 10, 1951
Presented at 1951 SAE Annual Meeting

IT is a rare privilege to join with you in again paying tribute to our dear friend, David Beecroft. It is a distinguished honor to follow, in this series of Memorial Lectures, such illustrious Americans as the first Economic Cooperation Administrator, the United States Commissioner of Public Roads and the Chief Justice of the Supreme Court of New Jersey.

Paul G. Hoffman, Thomas H. MacDonald and Arthur T. Vanderbilt are outstanding leaders, each in his own field and in the larger service of his country. Each, with warm human interest in his fellow man, has seen traffic safety as a worthy end in itself. Each, as philosopher and statesman, has also seen in traffic accidents a reflection of the supreme problem of our age: how to reconcile Man, who has changed so little in 50,000 years, with the Machine, which was born only yesterday. Will Man be destroyed by the machines he has created? The atom bomb has put this question on every tongue, but traffic has killed more than the bomb.

Accidents are Symptoms of Things Wrong

An accident, says the dictionary, is "anything occurring unexpectedly." For our usage we add "and resulting in injury or damage." Why do these things occur unexpectedly, without plan or intent? Because something was wrong, in our environment, our institutions, or ourselves. In traffic it may be something wrong in the vehicle, the road, the driver or the pedestrian—often in all four of these at once. When these things go wrong, sometimes they bring death, injury or damage, but *always* they bring delay, inefficiency, altercations, frustrations.

As accidents are symptoms of things wrong, so Safety means doing things right. It means achieving what you set out to do. Forget about the personal injury, even the death; that's incidental. Safety means that the housewife got her curtain hung, because she stood on a stepladder, not a rocking chair; that the carpenter finished his house, because he built a strong scaffold; that you reached your office on time because you drove with skill and caution.

Safety thus is a *quality*, present or absent in everything we touch and everything we do. In a factory it is associated with good management and efficient production; in a community, with good government; in an individual, with skill, forethought, consideration for others. "Safety," says Governor Youngdahl of Minnesota, "is a way of life for us."

The root causes of accidents are the root causes of all the great problems of the age. The ways of Safety are the ways of peace, cooperation, successful living. Analysis of the specific problems of traffic safety in terms of the larger problems of living together in this Machine Age will, I submit, help us better to understand both.

Man and the Machine

It once was fashionable to assume that the scientists, inventors and engineers were building a fine new world in which everything would be lovely. The automobile was an outstanding example. A chicken in every pot and two cars in every garage would usher in the millenium. Government was a nuisance, of small concern to decent people; education

Additional copies of this lecture, bound as a 28-page booklet, are available from SAE Special Publications Department at 50¢ to SAE members and non-profit organizations; $1.00 to nonmembers. Quantity prices on request.

We Live In

Sidney J. Williams

By Sidney J. Williams

Assistant to the President, National Safety Council

became more and more vocational; Technology was all the God we needed.

But it didn't work out that way. After a World War and a Great Depression, Owen D. Young said in a commencement address:

"We must not let this concurrent machinery of the physical and social sciences get out of balance. . . . I hope you in your generation will not confess to your incapacity to keep the sciences of government, of economics, and of the social order in step with the most rapid advances . . . in promoting the material welfare. . . .

"It will be necessary for you to find out what human behavior is, and then fashion the social machinery which will make for human happiness."

Had the generation which Mr. Young thus addressed in 1934 succeeded in the task he laid upon them, how different would be our world in 1951! Again, highway transport is an outstanding example. The mechanical control of the automobile is excellent; its social control through laws, education, custom and personal ethics has lagged far behind.

Most of us do not even understand the physical laws of motion and energy as they apply on the highway. We mistrust our statute laws and regard enforcement as a game between driver and cop, in which may the best man win. We think of driving as an inherent right, although legislatures and courts have repeatedly declared it a revocable privilege. Our traits of showing off, passing the buck, blaming the other fellow, trusting that everything will turn out all right, come into full flower behind the steering wheel.

Our whole attitude is adolescent. We blame the "teen-agers" for the very things we do ourselves. As individuals and as organized society we have not grown up to our motor cars.

Arnold Toynbee, who thinks in terms of millenia, has seen motor transport as an epitome of Western civilization. First he pictures "the premechanical road" on which the problem was that "of getting the journey accomplished at all." Then the road of today, on which. . . .

"The problems of speed and haulage have been solved. . . . But, by the same token, the problem of collisions has become the traffic problem par excellence. Hence on this latter-day road the problem is no longer technological but psychological. The old challenge of physical distance has been transmuted into a new challenge of human relations between drivers who, having learned how to annihilate space, have thereby put themselves in constant danger of annihilating one another.

"This change in the nature of the problem has, of course, a symbolic as well as a literal significance. It typifies the general change that has occurred over the whole range of our modern Western social life. . . . Everything that is now done in our society is done, for good or evil, with tremendous 'drive'; and this has made the material consequences of actions and the moral responsibility of agents far heavier than ever before."[1]

If we have not yet learned how to live with the automobile, which as a rule kills only one or two at a time, how can we hope to live with the radioactive atom which is 100,000 times more deadly? A devout and simple person, such as my grandmother was, might indeed say that the Lord had given us the automobile as a test, a proving ground on which

[1] A. J. Toynbee, "A Study of History" (abridgment by D. C. Somvervell).

through a few decades of relatively harmless experimentation we might develop social mechanisms to cope with both the Machine and the Atom; or, failing to develop them, face a deserved extinction. For such a test the motor car is ideal because of its universal use, its many blessings, its great mechanical power and the inevitable temptation to misuse that power.

Motor transport has in fact severely tested both us and our institutions. If we have not graduated cum laude, neither have we been flunked out of the course. We are slowly learning how to live with the automobile, and what we have learned may even help us to live with the Atom.

The Engineer's Responsibility

Technological progress has broadened our concept of the engineer's, and the manufacturer's, responsibility both for the integrity of his product and for its eventual use.

This was not much of a problem when the product was a plow or a pair of shoes and the designer-maker lived next door to his customer. Then, the law could well say "Let the buyer beware." Now, an invention like the automobile, or a new drug, has millions of buyers, most of whom do not understand it; and it has great power for harm as well as for good. The spavined horse was a joke on the buyer; the brakeless jalopy is a public menace. Where the public welfare is at stake, "caveat emptor" is no longer acceptable either in morals or in law.

The task of the early highway engineer was simple: to build pavements and bridges that would stand up under flood, frost, and traffic. Then came the broader concept of the highway as one element in a great transportation system whose total function is to move people and goods rapidly, conveniently and safely. Finally, Commissioner MacDonald in his epochal Beecroft Lecture showed how the highway must be designed for drivers as they are, not as we think they ought to be. We are, today, a long way from having such a highway system but at least the concept is clear.

Automotive design has followed a parallel course. At first we had to be content if the vehicle and the road were such that a careful, skillful driver could start from point A and arrive at point B without a breakdown. The driver had also to be a mechanic, ready to "get out and get under" at any moment.

Today a new car no longer carries a set of tools as standard equipment. Today your customers—which is to say, the public—expect much more. They expect not only the superlative mechanical performance which you have given them—and which is, incidentally, a bright star in the crown of our competitive free enterprise. They expect also a highway transportation system (including both road and vehicle) on which it not only shall be possible through skill and caution to avoid an accident but shall be difficult to *have* an accident. Modern ethical standards demand that our highway system like our factories be as nearly foolproof as possible.

There is no need to recite here the many steps you have taken toward that ideal. They include great improvements in the sturdiness and reliability of the car and its motor as well as the more obvious safety features.

On some problems however your progress has been less rapid. Among these are:

Driver vision or "blind spots" due to front and rear corners, exaggerated hoods and fenders, and other extremes of "styling." I don't want another Model T but it did let me see the curb.

Night vision, and particularly headlight glare.

Braking systems, especially for heavy trucks.

Accessibility of parts, for inspection and servicing. The "preventive maintenance" which we all urge would be simpler, hence more popular, if all vital parts were easier to get at.

Indicators and controls could be simpler and more foolproof, easier and surer to read and to apply. In aircraft design these items have been studied in minute detail by psychologists as well as engineers; granting the differences between piloting an airplane and an automobile, these findings still seem worthy of more attention by automotive designers.

Odd sizes of drivers, the very tall or very short, very heavy or very light, very long or very short of arm or leg, have received scant consideration. Must we not build cars, as MacDonald said of highways, for drivers as they are?

Other items would seem at least to deserve study. Bumpers could be better designed to absorb shock. Seat belts and even shoulder harnesses for passengers are more and more frequently urged, as are other crash protection measures. Some kind of "dead man control," or equivalent warning signal, would reduce the common hazard of falling asleep at the wheel. Our voluminous "fan mail," like yours, contains many crack-pot proposals but this question I found it hard to answer: when good brakes are so vital, why should "second and third grade brake linings" be advertised and sold?

In mentioning these unsolved problems I am far from implying that mechanical faults are the chief cause of accidents. The average car is undoubtedly safer than the average road, and both are safer than the average driver. I have spoken first of design, partly because you and I are engineers, and safety like charity must begin at home; but chiefly because in any problem the engineering solution, if there is one, is always the best. It is the easiest, because machines are easier to understand than people; they are more tractable, they don't talk back. The engineering solution also is the cheapest because it is permanent, while education and enforcement must be kept up year after year. "The traffic signal," says David Lilienthal, "is a simple social invention for living together more harmoniously."

I have no bright idea for solving any of the specific problems mentioned. I have great confidence that they will some day be solved by the same ingenuity and persistence with which you have already accomplished so much.

Coordination of Vehicle and Highway Design

To illuminate my next point, please bear with me in an absurd assumption: that we all were living under a benevolent, omnipotent, omniscient dictatorship.

Under this imaginary regime there would have been, beginning around 1900, a Highway Transport Planning Board. This group of miracle men would have planned, step by step, the mechanical develop-

ment of the motor vehicle and the parallel development of the highways and of legal and social controls. There would have been, for example, no more dispute over size, weight and speed of vehicles in relation to highway capacity than there is in a well-planned factory over size, weight and speed of machines in relation to floor capacity. Development of the whole highway transport system from decade to decade would have been orderly and harmonious.

Such super-planning is not only impossible but repugnant. But what we actually have had may almost be termed super-nonplanning. Year after year you have built more, better, often bigger and heavier and faster cars, trucks and buses. The highway builders have tried in vain to keep up with you; so have the legislators, tax experts, police and educators. The hot battle over truck weights and pavement destruction is only one example.

Some of this confusion and waste, including the waste from accidents, can be charged to the inevitable temporary inefficiency of democratic free enterprise which in the long run is so remarkably efficient. Still, the confusion should not continue indefinitely. The impossibility of complete super-planning is no excuse for permanent super-nonplanning. We should be able now to get together and make up our minds what kind of vehicles and roads we want and are willing to pay for.

The engineer's immediate responsibility is to build the safest possible vehicles and highways. His larger responsibility includes energetic support of such official and other programs as will bring maximum benefit and minimum harm to all who use or are affected by his product.

Government

Government is one of our chief devices for living together. And government—political science—is one of the social sciences which have had a hard time catching up with the Machine in general and with the automobile in particular. In our ever-shrinking, ever more complex world we cannot get along without government and we have almost equal difficulty in getting along with it.

We all want more help from, and less regulation and taxation by, government; but what helps one regulates and taxes another. Like the small boy who scrambled his biblical quotations and said "A lie is an abomination unto the Lord, a very present help in trouble," so the rugged individualist finds government an abomination in general but a very present help when he needs an unsecured loan or a protective tariff.

Some of our pressing problems are: How can we get the "good" citizen to vote, to take more interest in the people he votes for? How can we attract and hold better people in public office? How can government and free enterprise get along together? How can federal, state, county and municipal governments get along together? How can we accomplish in government the coordination that is taken for granted in private business?

Every one of these general problems of government is encountered in traffic regulation and safety. And all three of your Beecroft lecturers have contributed greatly to their solution.

Paul Hoffman has consistently maintained that government is primarily responsible for efficient, safe highway transportation and that businessmen, in fact all citizens, must help and support government to that end. This idea is quite a blow to the great American pastime of passing the buck to the "politicians" while at the same time abusing and thwarting them; yet the concept has made considerable headway. You all know how the automobile and other industries have supported the training of police, engineering and other traffic officials; the development of standards, of professional status and pride in their work; the recognition that the people of a city or state simply can't afford dishonest, lazy or stupid traffic police, judges or engineers. This has had far reaching repercussions toward better *general* functioning of government.

Arthur Vanderbilt, successful lawyer with a strong civic conscience, hence a leader in the organized bar and in politics, saw clearly in the sad state of the typical traffic court a cancer eating away at our whole judicial system, destroying public confidence, thus threatening a foundation stone of our democracy. His Beecroft Lecture pictured the great progress that has been made, the patterns that have been established, and the remaining problems of traffic enforcement by both police and courts. Under his leadership, New Jersey now has the best traffic court system in the country.

Again the byproduct is even more important than the direct result. Many lawyers who would themselves disdain to touch a traffic case, many judges of higher courts to which such cases never come, and a whole galaxy of civic organizations have been led to realize that none of us can afford to ignore what goes on in the "lower courts" which are in fact the foundation of our whole judicial system.

Thomas H. MacDonald, the world's foremost highway engineer and road builder, has made his greatest contribution as administrator of a very complex and delicate relationship between the Federal Government and the States. A lesser man either would have become cordially disliked as a usurper of state rights, or would have taken the easy path of subservience to local pressures. MacDonald's wise, patient, realistic middle course has not only given us a great national highway system; it has proved that Uncle Sam and his children can get along together. More and more States in their relations with counties and municipalities are following the same pattern of helpful cooperation.

The President's Highway Safety Conference

Hoffman, for Business, offered help; MacDonald, for Government, was quick to accept. Many others have shared the burden, notably the chairman of this meeting, Pyke Johnson. The flowering of this united thought and effort is to be seen in the President's Highway Safety Conference. This extraordinary institution has been aptly described by "The Chief" as "an unorganized organization." The phrase is a paradox and so is the Conference. It has no constitution or bylaws, no statute, no budget. If it is "run" by anybody it is "run" by the collective imagination and judgment of those, in and out of office, who have shown themselves the most able so to contribute; if this ever ceases, the Conference will quickly die on the vine.

This anomolous institution has somehow gathered to its bosom all the interests, forces, programs, prob-

lems and aspirations of traffic safety. It has captured the attention of the public. It has stirred the imagination and stiffened the backbone of safety workers both official and civic.

I hope some brilliant social or political scientist will, before memory fades, write a book on The President's Highway Safety Conference as a case study in what makes America tick. It will be a book which no one in the Kremlin could possibly understand.

The whole program of the President's Conference is based on cooperation between government and the people. Of many examples I shall mention only two.

Uniform Laws

For at least 25 years we have been wrestling with the problem of uniform traffic laws and ordinances. From the beginning we have shunned the primrose path of direct federal legislation on rules of the road, speed limits, driver licenses and so on—an inviting shortcut to quick results, but sure to bring endless controversies and local nullification. We also have recognized that no uniform or model law deserves such name unless it represents a real meeting of the minds of official, business, technical and civic groups. The results have clearly proved the soundness of this approach. State adoption of the five Acts of the Uniform Vehicle Code, and city adoption of the Model Traffic Ordinance, have been far from universal but certainly as rapid and as general as can be found in any comparable field.

We still have problems. We need to distinguish more clearly between substantial and literal uniformity. We need less lip-service at national meetings and more real support in state capitals; more willingness to hammer out a compromise and then stick to it. Still, our measure of success has been great enough to make Uniform Traffic Laws a significant case study in the practical working of our Federal Union of States.

The Annual Inventory

We all want the states and cities to do a better traffic job. As private citizens many of us think we know how the job should be done. As officials we don't like too much unsolicited advice, particularly from Washington, New York or Chicago.

Cashing in on the American zest for competition that sends most of us slightly crazy at World Series or Rose Bowl time, the National Safety Council nearly 20 years ago started a contest among states and cities for the best traffic programs and records. The contest caught on at once; governors and mayors came a thousand miles to receive the coveted awards—proving once more that praise, recognition, is far more potent than criticism.

Others then wanted to know how *they* could win an award; for in this country no one likes to be last. And so there developed, under the sheltering wings of the president's conference, the Annual Inventory of Traffic Safety Activities. All the states and most of the cities make, of their own free will, detailed reports such as no Federal law could extort from them. The reports, when compared with one another, show clearly just where and how your city or state, or mine, is leading or lagging. Civic pride then has something definite to work on: our engineering is pretty good but our school safety is poor and our police and courts are odoriferous—or vice versa. Collectively the reports show what kinds of programs bring actual results in accident reduction, what standards of performance should be set, and whether the nation as a whole is creeping forward or slipping back.

The inventory has not only helped to reduce accidents. It has shown how to get things done in this democracy.

Safety and the Schools

The Machine Age has had both educators and laymen in a dither as to the aims and methods of education. So many more young people go to high school and college. There is so much more to learn. To make matters worse the schools feel that they have been asked, rather unfairly, to take over certain training that ought to be done at home, from cooking and sewing to manners and morals. And the high schools and colleges are so busy equipping their students to earn a living that they have little time to teach them to *live*.

Education, like government, is one of the social sciences that has not yet caught up with the machine. And again the imminent, universal, concrete problem of traffic accidents has high-lighted the larger problems and is, I believe, helping to point the way to their solution.

In the grades it is easy to see the futility of teaching the three R's to a youngster who will shortly be killed crossing the street or playing with a chemical set. It is easy for the classroom teacher to spend a few minutes each week in simple safety instruction. It is easy to form school safety patrols, with the help of the police and of a local safety council or civic organization, all of whom find this a fertile field for good public relations. These things are now being done almost everywhere.

Statistics show how many thousands of young lives have thus been saved. Again, the byproducts are even more important. The children learn, by seeing with their own eyes, why we must have laws and police; why we must, as a practical necessity, be our brothers' keepers.

Driver Education

There is, to my knowledge, no evidence that this training in the art of safe walking carries over into the high school age to make the same youngsters safe drivers. Perhaps, having been taught to keep out of the motorists' way, they even feel that now it is up to others to keep out of *their* way. So we must start all over and train our young people in the middle teens in the art of skillful driving including the attitude of safe driving.

The argument for driver education, in classroom and behind the wheel, for every eligible student in every high school is simple and conclusive. Driving is more universally practiced than any other of the many manual arts now taught in these schools. It involves greater hazard, to the driver and to others. (If a girl is not taught how to cook, at worst her husband gets indigestion and a bad temper.) And certainly, considering today's and tomorrow's traffic, driving cannot safely be learned without definite

training by a qualified instructor. Several studies have indicated that trained drivers have only about half as many accidents and violations as comparable drivers without training.

The practical difficulties are: driver education requires trained teachers; it costs money; it raises questions of legal liability.

As to the first of these, such teacher training is now offered in many places, thanks to the fine work of the American Automobile Association, the New York University Center for Safety Education, the insurance companies and others. The financial problem of providing cars for practice driving has been greatly reduced by the generous offers of automobile manufacturers and dealers, through the efforts of the Inter Industry Highway Safety Committee, the AAA and others. Any question of legal liability of school boards or officers would seem one to be faced and solved, rather than to be used as an excuse for inaction. The whole subject of driver education has been clarified, coordinated and officially blessed by the National Education Association through its Commission on Safety Education.

It seems, therefore, little less than shocking that only one-third of eligible high school students are now receiving any kind of driver education and only 15% get training behind the wheel. This is something which we engineers in our larger responsibility cannot ignore.

The Teen-Age Driver

Here I must put in a word in defense of the much-criticized teen-age driver. According to meager available data the driver in the teens, that is, below twenty, has a lower annual accident rate than those in the early twenties and only slightly higher than the 25–29 group. The young driver is greatly influenced by the example (rather than the words) of his elders, especially his parents, and too often that example is bad. He craves adventure, he is full of animal spirits—which we find very useful when we send him into battle—and if that natural, normal urge is expressed in reckless driving it is often because we have offered him no other outlet.

If you have listened, as I have, to a panel discussion by teen-age drivers[2] I am sure you have been convinced that they appreciate the hazards and the responsibilities of driving quite as well as any of us. Student "courts," empowered to revoke a student driving or parking permit, often reach more realistic verdicts than their adult counterparts because they better understand both the offense and the offenders. Even the "hot-rods" have been found open to a friendly, constructive approach.

I do not minimize the problem of the young driver. It is part of the greater problem of giving to immature minds a firm foundation of moral values and emotional stability in a world filled with hate, conflict and destruction.

The young driver often deserves criticism but above all he needs help and a good example.

Colleges and Universities

The colleges and universities are meeting the growing demand for many kinds of training in or related to safety in traffic and elsewhere. They are giving undergraduate, graduate and short courses for highway, traffic and industrial engineers, police, and teachers; including safety in agricultural and home economics courses; playing host to regional institutes. The various kinds of in-service training today are too many for even the briefest listing. The colleges are looking also into safety on the campus and in their shops, laboratories, and residence halls.

Because safety touches everything, it touches every part of education.

Public Education

Perhaps the newest of all the social sciences is that of getting masses of people to think or do what we want them to. The art of propaganda is as old as politics or religion; the mass selling inseparable from mass production is trying, at least, to make it a science complete with market analyses, circulation audits and Hooper ratings. "Propaganda" has acquired unpleasant connotations but since the word comes from the Roman Catholic Church it should be sufficiently respectable for our use, especially as the full phrase "propaganda fidem"—spreading the faith—is just what we are talking about.

In safety we are deeply concerned with spreading the faith and we use all the techniques and devices of propaganda. And all the propaganda channels —newspapers, magazines, radio, television, the movies, outdoor and other advertising—have gone the limit in their support. Their close working relationship with the safety groups has produced a program of public education that is positive and accurate.

Equal praise must be given to that other great medium for public discussion, the innumerable civic organizations, national, state and local.

As a result the American people are quite well informed on issues relating to highway traffic—more so, I believe, than on the issues of international peace and domestic economy. Perhaps the propagandists too could learn something from a study of traffic safety.

Can propaganda alone prevent an accident? I don't know. Like the sermons against Sunday golf, those who most need it aren't listening. But even if propaganda per se has few put-outs it certainly has a great number of assists in building public attitude and supporting much needed laws, enforcement, training and the like.

Problems in Safety Education

We still don't know just how to teach safety or what methods are most effective. (All education is of course plagued by the same questions.) A normal person who has experienced an accident is not likely to make the same mistake again; how can we create in him this awareness, this attitude, before he has had the accident? Shall we scare him, kid him, or play it straight? Our best guess to date is: some of each. Don't be too obvious or too solemn; don't, as Kipling put it, "look too good nor talk too wise." Use praise rather than blame. Sell each group in terms of its particular interest which for the business man is profits (that was Hoffman's approach), for the politican votes and so on. Let the business man or the politician interject, as he generally will, "But anyway I don't want

[2] See "The Teen Age Driver," National Safety Council, 1949.

my people to get killed." For the individual driver, especially the young, make safety intensely positive, not a lot of don'ts, but skill in getting where you wanted to.

The Safety Movement has, I think, learned these simple facts a little better than have some other worthy causes. We look eagerly to the educational psychologists for further guidance. We think they would find in traffic safety education an excellent laboratory for the study of education in general.

We have learned, too, how interdependent are education, or propaganda, and enforcement. Neither alone can go very far for very long; combined, and backed by good engineering, they cannot fail.

The Human Factor

In traffic as in many other areas the great unknown is the "personal element," the "human factor." We, therefore, have had to design our laws, our enforcement and our education as the Romans designed their arches—empirically, by trial and error; not as the Hell Gate Bridge arch was designed, by mathematical analysis of strains and stresses. What could we not do with a calculus of human conduct!

Still, while the world was waiting for the calculus the Roman Arch was very useful. With good materials and honest workmanship it stood for centuries. So with respect to human conduct and its control on the highway and elsewhere, we must make full use of what we have learned by trial and error, hoping that psychology, politics (government) and education will some day acquire the exactness and assurance which they must have to keep pace with science and invention.

From accident records and other data, incomplete as they are, we have reached a number of working hypotheses. Among them are:

1. *Why people have accidents.* A driver or pedestrian gets into an accident (sometimes with the help of less-than-perfect engineering) for one or more of three main reasons:

a. He *can't* do better—physical or mental deficiency, temporary or permanent.

b. He *doesn't know*—has never been trained, has not acquired or has lost the requisite knowledge and skill.

c. He *doesn't care* enough—doesn't want to have an accident but doesn't sufficiently want not to have one. He is careless, reckless, inattentive, call it what you will. This category, "faulty attitude," is the one we know least about, so it tends to become a catch-all. At the extreme it approaches the homicidal or the suicidal.

The subdivisions of these three kinds of human deficiency would fill several pages. They are overlapping and interdependent. Strength in one area can compensate for weakness in another. The skilful young driver can take changes that the elderly cannot; conversely, the careful driver can get along with slower reactions and less perfect vision. Thus it is difficult to set definite standards for any one of these many variables. We must measure the whole man. To date, the best measure is his own accident (and near-accident) record.

2. *These defects can usually be corrected.* A permanent defect like faulty vision is generally correctible. A temporary defect like fatigue or liquor or drug influence can be avoided. Lack of knowledge or skill, bad driving habits, yield to retraining. Even faulty attitude can be improved by wise handling by the employer, judge, or driver license administrator.

The few incorrectible cases must, of course, be taken off the road. But the aim of both employers and officials should be and generally is, not to take every seemingly unsafe driver off the road but rather to make him fit to stay on the road. The driver improvement programs of a growing but still small number of state motor vehicle departments promise, I believe, the greatest results for the least money of any single safety measure now known.

3. *The accident-prone driver.* To say that X per cent of the drivers have Y per cent of the accidents means nothing; the mathematics of probability must be applied, with allowance for amount and kind of exposure. Such analyses have shown far more accident repeaters and far more accident-free drivers than would the normal probability curve.

Indeed, we do not need to prove that there are accident-prone drivers. There must be because people are different. Being widely different in all other respects, how could they possibly be alike in their propensity to make mistakes on the highway and thus, sooner or later, get into accidents?

I deplore the present tendency to make the accident-prone driver a scapegoat. Much of this discussion is uninformed. It tends to hide the fact that a great many accidents involve "average" drivers like you and me who just made one mistake too many. The accident-prone driver has never been exactly defined, perhaps cannot be; he must exist in varying degrees that shade imperceptibly into the equally nebulous "average" driver. Every driver is "accident-prone" at times. The accident-prone driver certainly needs more study, but our salvation lies chiefly in applying standard preventives to all drivers and particularly to those with bad records.

4. *The mass approaches* to controlling human conduct on the highway, through education, enforcement and safety organization, have proved themselves. They do bring mass results. Los Angeles drivers actually stop for a pedestrian crossing the street. We can promise any state or city that energetic, continued use of these standard techniques will reduce accidents, just as the Roman builder could promise that his arches would stand up. But the modern concrete arch is must more efficient. The more we can learn about human conduct, the greater results we can get at the same or even less cost—which is quite an important consideration.

5. *Psychophysical tests.* Some progress has been made in developing practical tests to indicate whether a given individual can probably become an efficient, safe bus or truck driver. One of the best of these is the Motorability Test of the American Transit Association. The Third Avenue Transit System in New York City checked the records of 40 operators selected in 1949 by their "new criteria" including this test, against the record of forty operators selected in the two preceding years through the use of their "old criteria." During a three-

month comparison period the first group had less than half as many accidents as the second group, and only one third as many accidents listed by the company as "preventable." It still is not clear whether such results are due to the merit of the particular tests or to the general impression they give to the new employee that the company is serious about safety.

The employer can use such tests because he is under no legal obligation to hire a probable bad risk. The driver license administrator, on the other hand, cannot turn down a license applicant without clear evidence of his incapacity to drive safely. No psychophysical test yet developed can provide such evidence except as to certain obvious physical defects.

Another kind of check-up is sociological. Dr. W. A. Tillman has shown that "men drive as they live" —that those who get into trouble with the law or with their fellow men have more accidents. It still seems probable that some of these bad actors, who jump their bills or beat their wives, could be made into better drivers.

We need much more study of physical, mental and moral characteristics in relation to accidents.

The Ethics of Driving

The automobile is putting our manners to a grave test. Why are so many "gentle" men and women so ungentle when behind the wheel, so inconsiderate, so prone to blame the other fellow? Are we really that selfish at heart? Is our courtesy in other daily contacts just a thin veneer, imposed by custom, which breaks down under a new stress? Or is it simply that bad manners behind the wheel are more annoying and more harmful than in most other contacts? It will be interesting to see whether the rising generation, to whom the automobile is not an exciting new toy but as commonplace as indoor plumbing, shows better motor manners.

If we could discover just why a steering wheel and a hundred-horsepower motor turn some of us into barbarians, perhaps we could also deal more effectively with the root causes of interclass, interracial and international strife.

Are We Too Sorry?

What I am going to say next may sound like rank heresy but is in fact entirely consistent with the positive, constructive concept of safety.

The prophets of gloom are fond of saying that mass production destroys pride of craftsmanship, network comedians and syndicated columnists stunt individual thinking, the Welfare State discourages initiative and self-reliance. We expect the state to protect us against everything unpleasant—poverty, illness, foreign competition, accidents. We feel sorry for the victim of any misfortune, forgetting that what happens to us is largely our own fault.

I feel quite sorry for myself if I get a bad cold and have to stay in bed. My family does not feel sorry for me. They feel, and don't conceal it, that I could have avoided the fatigue or exposure that led to the cold; that my sneezing and coughing and demanding meals on a tray is actually an imposition on the rest of them. And they are quite right.

The great majority of accidents could have been avoided by "defensive driving" (or walking) on the part of the victims, even when "the other fellow" or the car or the road was grossly at fault. For proof, look at the extraordinary no-accident records of many truck and bus drivers.

Sympathy and help for the unfortunate is one of our finest traits. But undiscriminating sympathy for the victim of a self-invited misfortune does not breed either wisdom or character in the recipient. We who enjoy the benefits of the Machine Age must accept the attendant responsibilities.

I suggest then that we stop feeling so sorry for the able-bodied adult accident victim. Help him if his injury is severe but censure him for his error of commission or omission which permitted the accident to occur. Many fleet operators already regard accident involvement, with suitable exceptions, as prima facie indication of unsafe driving. Some driver license administrators take a similar view.

Might even our traffic laws recognize this same principle? These now attempt to prescribe in detail just what the driver shall do under a wide variety of circumstances. Yet we know that safe driving is a matter of skill and judgment rather than of memorizing a long list of rules. Might the law declare the general basic rules of right-of-way, speed, overtaking and passing and the like, which also would provide the basis for enforcement in non-accident cases; and then declare further that involvement in an accident shall be prima facie indication of an illegal act? To work this out in practical detail will not be easy; the very idea may seem revolutionary—but so is the self-propelled vehicle!

Among the list of Beecroft lecturers one notes with regret the absence of any psychologist, moralist, teacher or moulder of public opinion. The sad fact is that while many workers in education and public information have rendered great service to the cause of safety, no top ranking national figure in any of the four fields mentioned, comparable with Hoffman, MacDonald or Vanderbilt, has as yet given any such leadership as they have given. Safety urgently needs such leadership. Even more important, such explorations with respect to traffic and other accident causes and prevention would help to solve the general problems of psychology, morals, school and adult education. It is to be hoped that leadership in these fields will arise and will be recognized before the conclusion of this series of lectures.

Research

Can you imagine the development of the modern car in so short a time if your companies, and the university laboratories, had not spent many millions on research, experimentation and testing of every conceivable kind? Is there any doubt that the investment has paid off? How often has research been acclaimed as the foundation stone of American progress and prosperity!

To say that the *use* of the automobile—the highway transportation system as a whole—has received no such study is a new record in understatement.

There have been valuable researches in highway construction: pavements, subgrades and the like; not so many, not nearly enough, in highways as something to be used, that is, in traffic engineering.

As for the really sound, significant studies of human conduct on the highway, you can count them on your fingers; their total cost would hardly pay the traffic accident bill in Detroit alone for a single week.

I am not talking only about safety—though increased travel has pushed the 1950 traffic death toll to the highest since 1941. I am talking also about convenience, overall efficiency and economy. We spend billions annually (and still not enough) on building and maintaining our streets and highways and on police, courts, driver licensing and education. We are spending these great sums as wisely as we know how, and I do not apologize for the efforts or the results. But on many items of this vast program we must perforce base our plans on judgment, opinion, guesswork. Research, and research alone, would enable us to do much better—and do it more cheaply. What we spend on our highway transportation system *every two hours* would finance the entire research program recommended by the Research Committee of the President's Highway Safety Conference.

The inspiring program of the Ford Foundation comprises five great areas: peace, government, economics, education, and human conduct. In all but the first of these areas and particularly in the last, highway traffic encounters vital and difficult problems. As the Ford program unfolds, it should give us some of the answers. May one hope that Ford will have as much competition in this field as in selling cars?

The Safety Man

Having offered no little criticism and advice to everyone else I must in common decency attempt a brief soul-searching on behalf of the one group for which I may be presumed to speak: the men and women who make a living in the organized safety movement. Indeed, for us the giving of gratuitous advice to others is a constant temptation if not an occupational disease. Sometimes the advice is based on superficial, even inaccurate data. We must deal with so many things that we can't know very much about any of them.

Most of us recognize that fact. We sit at the feet of the Hoffmans, the MacDonalds and the Vanderbilts and try to learn from them. We fervently pray for a great psychologist, a great teacher, a great moulder of public opinion to take place beside them.

When tempted to criticize a business man or a politician for not doing, at once, what we think he should, we must remember that business cannot survive without profits or politicians without votes and that too great a risk of either can be expected only on the soundest evidence. We are convinced that safety is good business and good politics but we must continually prove it.

We are proud of our accomplishments but humble as we review our failures, most of them our own fault. We pray for deliverance from the deadly sins of smugness, of intolerance, of unrealism, of hasty generalization, of taking ourselves too seriously, of mistaking the means for the end, of ever once failing to practice what we preach.

We do not apologize for watching our membership rolls and our bank balances, for we too must survive. But we know that members and income, column-inches and radio-hours, speeches and committees and conventions are as sounding brass and a tinkling cymbal except as they help to save lives, to help democracy itself to live.

Conclusion

These observations, ranging over such diverse fields as engineering, government, education, and personal conduct, fall into a clear pattern:

1. We have not yet grown up to our automobiles. Our time is a time of adolescence and traffic accidents are one of our growing pains.

2. We are gradually growing up, more rapidly in some directions than in others. We have reacted and adapted to the hazards of the motor vehicle much faster than we did to those introduced by the Industrial Revolution.

3. Our traffic problems and efforts are in no way unique or different. They are part and parcel of the great task of our age: to adapt our institutions and ourselves to the New World—much more of a New World than the one Columbus discovered—which the machine has created; a world in which I must be my brother's keeper if either of us is to survive.

This New World has given us much. It demands of us, in return, maturity and responsibility. No longer may we quarrel over the right of way as children quarrel over a new toy, with no worse penalty than a bloody nose. Psychologists say that temper tantrums in children are normal and no cause for alarm; but we can't afford a temper tantrum in a "child" of any age behind the wheel. The wages of sin, even a very little sin like speeding, is death.

We must be willing to pay the cost—all the costs—of motor transportation, in tax dollars, in self-control, in acceptance of legal and social controls.

We must of necessity be "members, one of another." The engineer and the manufacturer in Detroit are responsible for the driver and the pedestrian in Maine or California, even as these are responsible for each other. Government is responsible for our safety and we are responsible for our government. We will defend with our lives the dignity and the freedom of the individual, but the individual must earn that freedom and that dignity.

We must be as ready to experiment with new techniques of education and of government as with new forms of matter and energy. We must, with Sumner Slichter, recognize our present society "as remarkably vigorous, robust and dynamic," with problems which "are largely the products of this robustness and vigor."

In our adolescent society we have achieved an uneasy modicum of safety, largely through enforcement and propaganda. In a mature, responsible society safety and convenience in highway use will result naturally from good cars, good highways, individual skill and, above all, individual concern for others.

What we have done, are doing and must increasingly do for traffic safety is important because it saves lives and makes our highway transportation system more efficient. It is even more important because it shows the way to better government, better education, better understanding and control of ourselves.

CALENDAR

Baltimore—April 12
Engineer's Club, Baltimore; Ralph S. Damon, president, Trans World Airline.

British Columbia—March 12
Hotel Georgia, Vancouver, B. C.; dinner 6:30 p.m. Turning Characteristics of Vehicles—Edwin L. Mills, highway traffic engineer, Western Highway Institute.

Chicago—March 13 and March 19
March 13 — Hotel Knickerbocker, Chicago; dinner 6:45 p.m. Meeting 8:00 p.m. Liquefied Petroleum Gas as an Automotive Fuel—A. J. St. George, assistant branch manager and engineer, Ensign Carburetor Co. Social Half-Hour, 6:15 to 6:45 p.m., sponsored by Voltz Bros., Inc., and International Harvester Co.
March 19—Hotel LaSalle, Bronzewood Room, South Bend; dinner 6:45 p.m. Meeting 8:00 p.m. Styling—Raymond Loewy, Raymond Loewy Associates. Former SAE President S. W. Sparrow will be chairman of meeting.

Cleveland—March 12
Hotel Lake Shore, Cleveland; dinner 6:30 p.m. Flight Testing of High-Speed Aircraft—R. M. Edholm, chief engineering test pilot, MacDonald Aircraft Corp.

Colorado—March 9 and April 12
March 9—Top of the Park, Park Lane Hotel; dinner 6:30 p.m. Ladies Night, annual dinner and dance.
April 12—Engineering Problems—New Car Design—James H. Booth, Thompson Products, Inc.

Detroit—March 21 and April 2
March 21—Field trip through DeSoto Body Plant, 8505 West Warren, Dearborn; 1:30 p.m., Junior Group.
April 2—Hotel Commodore Perry, Detroit; Economics of the Small Car—D. G. Roos, Willys-Overland Motors, Inc.

Metropolitan—April 5
The Brass Rail, New York; cocktails 5:30 p.m. dinner 6:30 p.m. Meeting after dinner. Passenger Car Riding Comfort — Ross McFarland, B. F. Geisey, vice-chairman, Passenger Car Activity.

Milwaukee—April 3
Graduate House, M.I.T.; dinner 6:30 p.m. Meeting 7:15 p.m. Truck and bus speaker to be announced.

Mohawk-Hudson Group—March 14
RPI, Troy; dinner 6:30 p.m. Meeting 8:00 p.m. Manufacture of Plain Bearings—Edward Crankshaw, engineer of sales, Cleveland Graphite Co. Joint meeting of RPI Section branch.

Pittsburgh—March 27
Webster Hall, Mallon Institute; dinner 6:30 p.m. Meeting 8:00 p.m. Passenger Car Styling, speaker to be announced.

St. Louis—March 13
Hotel Congress, St. Louis; dinner 6:30 p.m. Meeting 8:00 p.m. Use of Propane and Butane Gas for Motor Transportation—F. E. Selim, auto service engineer, Phillips Petroleum Co.

Spokane Inter-Mountain—March 23
Hotel Spokane, Spokane; dinner 6:30 p.m. Meeting 8:00 p.m. Private Enterprise and Democracy—Kim Jack, personnel director, Washington Water Pur. Co.

Southern California—March 15
Rodger Young Auditorium, Los Angeles; dinner 6:30 p.m. Meeting 8:00 p.m. Automotive Gear Lubricants and Greases—John M. Stokely, senior research engineer, California Research Corp.

Twin City—March 14
Hotel Curtis, Minneapolis; dinner 6:30 p.m. Meeting 8:00 p.m. The Operating Principles of Rochester Carburetors—Don Stoltmali, exp. engineer and F. D. Lowell, service procedurer, Rochester Products Division, GMC.

Western Michigan—March 13
Hotel Occidental, Flint; dinner 6:30 p.m. Meeting 8:00 p.m. Annual National President's Dinner, SAE President Dale Roeder, Ford Motor Co. Top management of automotive industries in Western Michigan Section invited to attend.

NATIONAL MEETINGS

MEETING	DATE	HOTEL
	1951	
AERONAUTIC and AIRCRAFT Engine Display	April 16-19	Statler, New York
SUMMER	June 3-8	French Lick Springs Hotel, French Lick, Ind.
WEST COAST	Aug. 13-15	Olympic, Seattle, Wash.
TRACTOR and PRODUCTION FORUM	Sept. 10-13	Schroeder, Milwaukee
AERONAUTIC, PRODUCTION FORUM, and Display	Oct. 3-6	Biltmore, Los Angeles
TRANSPORTATION	Oct. 29-31	Knickerbocker, Chicago
DIESEL ENGINE	Oct. 29-30	Drake, Chicago
FUELS and LUBRICANTS	Oct. 31-Nov. 1	Drake, Chicago
	1952	
ANNUAL	Jan. 14-18	Book-Cadillac, Detroit

Fuels Tested on Light Aircraft Engines

Based on paper by

V. E. YUST

Shell Oil Co.

TO establish the effects of various operating and fuel variables on the performance of a full scale light aircraft engine, field and laboratory tests were conducted, using a horizontally opposed four cylinder aircooled engine with 7:1 compression ratio pistons.

In field equipment, operating fuel-air ratios were found to vary from 0.075 to 0.105 in the full rich mixture control position for engines of the same type. Four carburetors tested in the laboratory had a total spread of 0.062 to 0.094 fuel-air ratio at a simulated cruise airflow and 0.07 to 0.099 fuel-air ratio at a simulated take-off airflow. Thus, the variation at simulated cruise covered a range from too lean for stable operation to a rich mixture giving high fuel consumption. A lean mixture at take-off may give a substantial increase in octane requirement.

Actually, these variations in ratio affect the octane requirement of the engine as much as 4 to 6 units, and fuel consumption as much as 50%. Rich mixture, therefore should be used for take-off, but not for cruising.

The carburetor and cooling air temperature for a light aircraft engine in service varies with the season of the year and is also influenced by the use of carburetor heat. A decrease in this temperature from about 100 to 50 F decreased knock limited output at rich mixture by about 12%, which loss is equivalent to a 5-unit increase in the octane requirement. An increase in temperature to 110 F produced a decrease in knock limited performance over the entire air-fuel range. Fuel consumption at 100 F carburetor air test conditions was found to be about 6 to 7% lower than for 50 F.

It is apparent then that 100 F is the optimum temperature and that abnormally low or high carburetor and cooling air temperatures had a deleterious effect on octane requirements. Low temperatures also increased fuel consumption.

The tests also revealed that variations in spark timing and adjustment of the cooling air baffles affected engine performance.

The combined effect of all these variables is of such magnitude that take-off octane requirement was increased from 81 to 97, or an increase of 16 units, while fuel consumption was increased as much as 70%. The cumulative effect is shown in Figs. 1 and 2.

Commercial 80-grade aviation fuels produced prior to the advent of the F-4 87 octane number specification showed a substantial difference in full scale engine knock ratings. However, these differences were small in comparison with the effects of operating variables on octane requirement. Since the F-4 rich rating was found to correlate reasonably well with take-off performance, fuels meeting the new F-4 requirement should vary less in knock characteristics and minimize the possibility of detonation and engine failure. Automotive gasolines were inferior to 80-grade aviation gasolines, particularly under take-off conditions. (Paper "Light Aircraft Engine Tests—Fuels and Operating Variables," was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 9, 1950. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Product Service Plays Vital Role

Based on paper by

PHILIP H. EMRICH

Vickers, Inc.

WELL organized and efficient product service cannot be achieved when it is the secondary interest of some other department. It must not be limited in scope and authority by indifference or preoccupation with other functions. Therefore, the department must have top level management support.

Product service responsibilities fall into four basic categories: repairs, replacement parts, product improvement, and publications.

A byproduct of repair service will be a wealth of information obtained from

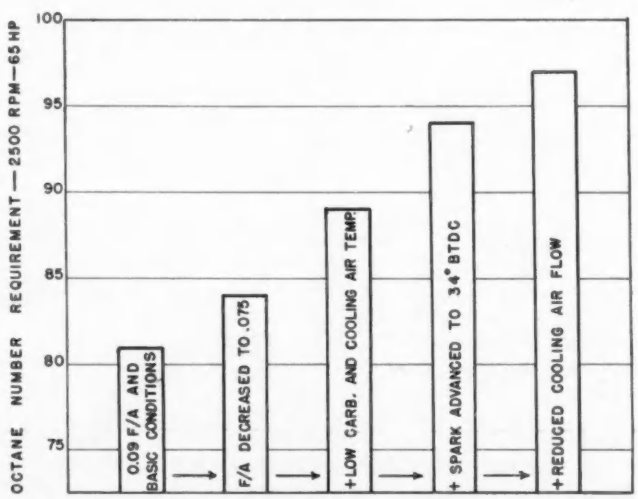


Fig. 1—Cumulative effect of operating variables on the take-off octane requirement of light aircraft engines

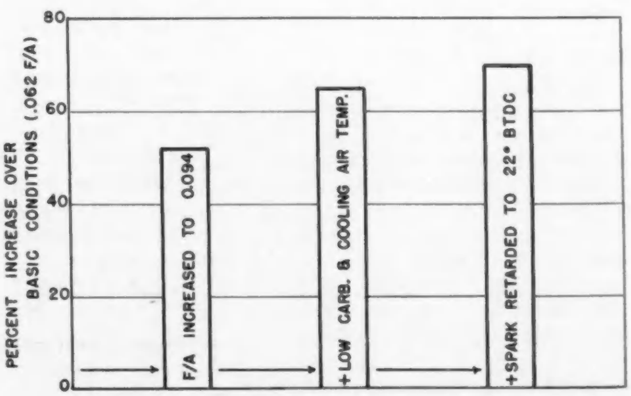


Fig. 2—Cumulative effect of operating variables on the cruise fuel consumption of light aircraft engines

mplaints, and complaint facts are the most accurate measure of product acceptance and the surest road to product improvement. Proper use of product improvement news stimulates sales, assists advertising plans, benefits production through improved methods and helps the service man with the latest repair wrinkle. (Paper "An Accessory Manufacturer's View of Field Service," was presented at SAE Annual Meeting, Detroit, Jan. 8, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Developments in Truck Refrigeration Units

Based on paper by

W. E. PETERSEN

International Harvester Co.

DEVELOPMENT of mechanical refrigeration for delivery trucks is progressing along two main avenues—refinement of the method of using power from the truck engine, and perfection of the independent refrigeration system.

Two means of taking power from the crankshaft extension are available; one is direct and the other is through a belt, gear or chain. In the direct connection the electric generator is mounted between the radiator and the bumper. The other method is to mount a generator, refrigeration compressor or power take-off shaft under the hood, support it from the engine and supply power by belt, gear or chain.

When mounted in front, the generator was easily damaged in collision, whereas under hood mounting proved vulnerable to engine heat. Installation of satisfactory drive belts, gears or chains was a complex problem and in addition the electrical equipment was too heavy and complex for the average mechanic to service.

Most refrigeration compressors are designed to run at a constant speed, consequently the tolerances are close. When operated at the varying speeds of the truck engine, a compressor tends to heat and stick, which appreciably shortens its life. And another drawback to the under-hood, direct belted compressor system is that it furnishes refrigeration only as long as the motor runs.

Power take-off drives from the transmission have been developed for direct mechanical drive, hydraulic drive and magnetic drive. The principal obstacle to a transmission power take-off drive has been its interference with normal gear shifting. During shifting the power take-off must be disconnected, thus posing another complex clutching problem.

The independently operated refrigeration unit generally consists of a gasoline engine driving a compressor through belts. Some systems may have an electric motor that will also operate the unit on a standby basis when connected to a source of current. Most units are thermostatically controlled. The unit's gasoline engine is started and stopped by a refrigeration thermostat, or the engine runs constantly and is engaged and disengaged by a thermostatically activated clutch. Liquid cooled engines are replacing air-cooled ones to gain dependability even though a little weight is added. (Paper "Refrigeration of Delivery Vehicles," was presented at SAE Annual Meeting, Detroit, Jan. 8, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Synthetic Rubber Comes of Age

Based on paper by

E. R. ROWZEE

Polymer Corp., Ltd.

IT was widely held that production of synthetic rubber had effectively stabilized the price of natural rubber, at least to the extent of preventing extreme fluctuations. But the advance in natural rubber prices last year, the most spectacular in 25 years, has halted this view completely.

The change in viewpoint is important because the prevailing high price of natural rubber has caused manufacturers of rubber end products to weigh carefully the value which they place on the natural versus the synthetic. Even more important are the following.

1. Rubber consumers the world over, but especially in the U. S. and Canada, have now had eight years experience with the synthetic. They know its advantages and disadvantages.

2. Synthetic rubbers have improved markedly during the past several years and will improve more.

The foregoing facts establish a reference point quality-wise which must be related to price. The price of the basic types of the synthetic have been stable for several years. Prices may fluctuate from time to time due to inflationary or deflationary trends and changes in rate of exchange, but it is certain that synthetic rubber has achieved a degree of price stability which natural rubber cannot hope to match.

This paper also describes the operations of a company organized in Canada during World War II to make synthetic rubber. (Paper "Synthetic Rubber Comes of Age," was presented at SAE Canadian Section, Toronto, Oct. 18, 1950. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Plan for Jet Age Travel Uses 3 types of Craft

Excerpts from paper by

M. D. WARSHAW

Manager of Schedules, Trans World Airline

WHEN the day of the 600- or 700-mph jet transport arrives, airlines schedulers hope that the jets can be supplemented with 120-mph helicopters and 400-mph turboprop transports.

Then no two cities in the country need be more than eight hours apart. Service will be better—and probably more economical.

Here is how the three types of equipment will be used:

Helicopters will take passengers from the downtown area of a city to the airport and from the downtown area of one city to the downtown area of another city falling within the 150-mile "microhaul" range.

No city is more than an hour from an airport.

Turboprop transports will carry passengers from "secondary" airports at moderately large cities to "primary" airports and back and between one secondary airport and another in the 150-500 mile range.

With 400-mph transports, no secondary city is more than an hour from a primary city.

Jet transports will operate between primary airports of cities at least 500 miles apart. Primary cities on opposite coasts are only about four hours apart with 600-mph-plus transports.

Since the helicopter flight to an airport 50 miles from a city's downtown area will take no more time than a limousine now takes to closer airports, primary airports can be located farther from congested downtown areas. There will be room for the longer runways that jets may require and more of them—even room for multiple airports.

If primary—and secondary—airports

are centrally located between two or more cities, the airport can serve more people. Not only will there be more people to share airport costs, but also to fill the airplanes. Nonstop flight will be easier to fill, so more can be scheduled. Service will improve while per-passenger costs decrease. (Paper, "Fundamentals of Airlines Scheduling and Flight Equipment Routing after 1955," was presented at the SAE National Aeronautic Meeting, April 18, 1950.)

Boosting Efficiency of Insulated Trailers

Based on paper by

V. M. DREW

Fruehauf Trailer Co.

PRACTICAL operators may scoff at laboratory testing of insulated trailer bodies, but the fact remains that where design characteristics and application methods are tested, under controlled conditions, certain factors of real importance can be evaluated with a high degree of accuracy, thus sparing the user the cost and embarrassment of experimentation.

Actual 28, 30, 32, or 34 ft trailers have been tested in a fully enclosed laboratory room in which any desired temperature range as high as 110 F can be maintained for extended periods of time. By using accurately calibrated recording thermometers or thermocouples distributed about the interior of the trailer, the actual rate of heat flow and its effect on a specific quantity of fixed rate heat absorbing medium can indicate definitely the overall thermal efficiency of the body in terms of Btu per hour per degree of temperature differential per pound of medium evaporated.

In similar manner tests can be run to determine the performance characteristics of various types of heat absorption media including mechanical refrigeration units.

There are numerous ways to increase overall thermal efficiency. One of them is to use bright surfaces. If the outer body panels of a commercial body are made of highly polished metal, such as aluminum or stainless steel, and are left unpainted, the thermal efficiency of the unit will be increased. It is believed the advantage runs as high as 10% under certain conditions, particularly in sunny climates. If paint is used for protection, a light color is preferable.

Provision should be made for keeping insulation as dry as possible. In current practice it is impossible to construct a hermetically sealed chamber between inner and outer walls, and suitable drainage must be provided. "Weep holes" located at regular intervals along the lower side or bottom of the side walls will handle single walls of 6 in. thickness or less, but in double wall construction baffle plates are needed to direct the inner wall condensation into the body interior.

Where loads are relatively dry, wood top floor and plywood, or its compounded equivalent, are acceptable for sidewalls. But where excessively wet loads are carried, or there is compulsory preloading cleansing with steam or hot water under pressure, there is no substitute for a metallized interior.

Metallization ranges all the way from thin metal sheets over plywood to corrugated alloy steel or aluminum sheets which require no backing for strength. The latter are gaining in favor because they afford attractive weight reduction possibilities.

Floors require more engineering ingenuity. At present, light metal extrusions of either magnesium, aluminum or preformed stainless steel, are favored by experienced operators. These extrusions are formed with a contour which provides longitudinal troughs for the disposal of waste water and for underload air circulating channels, which is highly important, not to mention a long wearing top surface. (Paper "Refrigeration of Highway Transport Vehicles," was presented at SAE Annual Meeting, Detroit, Jan. 8, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Fuel Road Rating Accuracy Improving

COOPERATIVE testing is bringing closer together fuel road ratings by the Borderline and Modified Uniontown techniques. The Road Test Group, of the CRC Motor Fuels Division shows this in its report "Analysis of 1949 Road Rating Exchange Data."

The Road Rating Exchange Panel of the Road Test Group found encouraging the results of its three-part 1949 project. Cooperative test programs were held in the spring, summer, and fall. Average deviations between spring and fall were reduced by 0.3 of an octane number by both the Borderline at 1000 rpm and Modified Uniontown methods.

Overall deviation from average for all cars, fuels, and laboratories during the spring program was 1.18 for Borderline at 1000 rpm and 1.17 for Modified Uniontown. Same figures for the fall program were 0.98 and 0.86.

The Road Test Group's Analysis Panel finds the accuracy improvement encouraging. But it feels more work must be done before setting up acceptable limits for either of the two techniques.

Results also point up possible correlation between average absolute methods from the Modified Uniontown and Borderline technique at 1000 rpm. Here is how average ratings of three car makes and the fuels used in the spring and fall projects compare: Borderline ratings are about 0.4 units high in the 77/81 range, equal in the 87/91 range, and 0.6 low in the 98/100 range.

The program confirmed two things surmised all along: (1) that cooperative effort can eliminate, or at least minimize, personnel and technique errors in road rating, despite its complexity; and (2) that severity reference fuels can be made available with anti-knock characteristics close to those of commercial fuels now marketed.

The report, CRC-254, has 42 8½ × 11 pages, including 13 charts. It is available from the SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.

Better Ignition Is Imperative Need

Based on paper by

L. H. MIDDLETON and M. F. PETERS

Electric Auto-Lite Co.

DESIGNERS using higher compression ratios and valve-in-head engines to improve mechanical and thermal efficiencies are rapidly approaching the minimum performance requirements of present-day distributor and coil type ignition systems. It is mandatory, therefore, to re-study the overall system effectiveness in order to bring about maximum utilization of the energy available.

Primary current limitations imposed by the high speed primary contact breaker mechanism limit the total amount of energy available, and increase in top speeds of overhead valve engines reduces the duration of primary excitation to a degree where it has become necessary to improve the efficiency of the overall system substantially in order to meet these new demands.

Unless a means can be found to justify the reduction of the so-called utility value of the spark, it will become

necessary to increase the energy output by increasing the primary current, thus shortening the life of the breaker points and limiting the long-term usefulness of the system.

It has been assumed generally that the modern ignition coil produces more total energy than was required to discharge a spark across the electrodes of a well insulated secondary system and had sufficient reserve to assure sparking with spark plugs fouled to a relatively low electrical resistance. This reserve of energy has in the past been measured by the ability of the spark generating system to fire a low resistance fouled plug, and was measured and stated in terms of "utility."

It now appears that if this reserve energy can be more effectively utilized, it should be possible to reduce its value and use the excess energy to charge the secondary circuit to a higher voltage without affecting the total reliability. Studies indicate that by limiting the rate of voltage rise to a range of predetermined values, a large part of the energy now reserved for the utility component can be used for charging the secondary circuit to a higher voltage without decreasing the probability of sparking. (Paper "Optimum Rate of Voltage Rise for Minimum Energy Loss in Ignition Systems," was presented at SAE Annual Meeting, Detroit, Jan. 8, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.

Mass Marquenching For Better Products

Based on paper by

W. B. CHENEY
and W. C. HIATT

International Harvester Co.

MARQUENCHING has made it possible to produce gears with a minimum of residual stress, thereby lengthening their service life from 100 to 200% and increasing their load-carrying capacity from 15 to 20% as determined by dynamometer testing.

Marquenching is the name given to a process using a type of interrupted quench. Since oil at 400 F is used as the quenching medium, the temperature is not adjusted to the M_s point for the types of steel processed.

Provisions were made to Marquench on five radiant-tube gas carburizers and in development work, using a Quench-Master, it was determined that gears could be quenched within specified tolerances without the use of quenching presses, plugs, or special fixtures, and a fine martensitic case structure obtained.

Mass Marquenching was then attempted and carried out successfully after making improvements in tank design and agitation. By way of example: one transmission had 13 carburized parts of which five were press quenched, five plug quenched, one individually quenched, and two batch quenched. Now these parts are all batch quenched with tolerances and bearings within limits.

At the present time, approximately 75 different parts are being processed which range in weight from ½ to 12 lb, with solid sections from ½ to 2½ in. Among them are transmission gears, differential side gears, pinion gears, king pins, and miscellaneous shafts.

The benefit from this process is not in correcting errors in tolerances, but rather in holding stress to a minimum. In establishing this process on different parts, samples were checked in the green and spotted throughout regular production runs for the gathering of data. Fig. 1 presents a comparison of the distortion of conventional and Marquenched king pins. Fig. 2 compares runout between conventional and Marquenched hypoid gears. (Paper "Mass Marquenching," was presented at SAE Annual Meeting, Detroit, Jan. 8, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

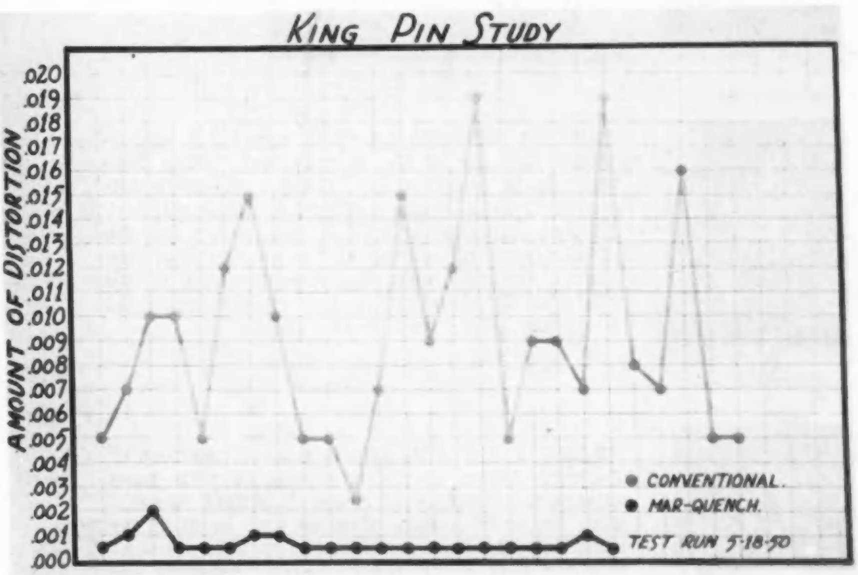


Fig. 1—Comparison of distortion in king pins conventionally processed and Marquenched

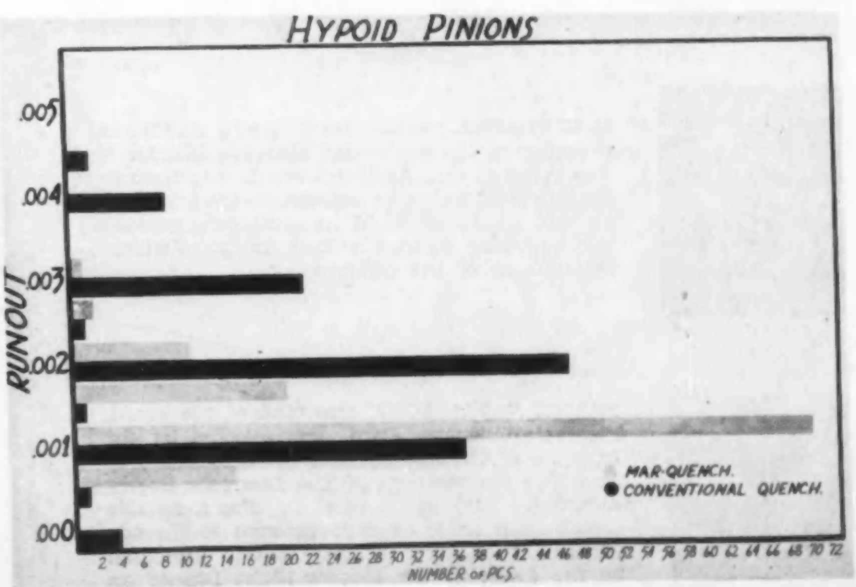


Fig. 2—Comparison of runout between conventionally processed and Marquenched hypoid gears

About

DEAN HAMMOND has been appointed vice-president in charge of engineering at Kaiser-Frazer Corp., Willow Run, Mich. Hammond had been chief engineer of the company.

DAVID C. PRINCE, vice-president of General Electric Co., Schenectady, N. Y., has been named to the president's staff, with special duties as assigned. He has been responsible for many important design developments, not only in such fields as switchgear, but also electric locomotives, ship control, electronic tubes, and many others.

CHET D. HIRSCH has been appointed educational director of the Bendix Automotive Service Sales organization, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind. In this capacity he will be responsible for the development of service and sales training programs, training aids, and coordination of all educational programs in the service school at the home office, and in the field.

FRANK J. HODER, JR., is one of two former Packard Motor Car Co. associates who have established the firm of Hoder & Kollar, specializing in coordination of sales and engineering activities of client-manufacturers with current military production needs. Hoder recently resigned as manager of Packard's marine and industrial engine department.

R. H. CLARKE has been transferred from district manager of the Southern California District of The Autocar Co., Ardmore, Pa. to the Autocar Factory from which, as assistant to the president, he will assist in handling Autocar's growing relation with various officers of the Defense Department of the Government.

FRANK N. PIASECKI, chairman of the board, Piasecki Helicopter Corp., was selected by the Institute of the Aeronautical Sciences Board of Award as the recipient of The Lawrence Sperry Award for 1950 which is given "For a notable contribution made by a young man to the advancement of aeronautics". It was presented by the I.A.S. at the Honors Night Dinner on Jan. 29.

DR. THEODORE P. WRIGHT has been named acting president of Cornell University. A past vice-president of SAE, Wright has been serving for several years as vice-president for research of Cornell. He has also been president of the Cornell Research Foundation and chairman of the Cornell Defense Coordinating Council. This latter agency is formulating plans for Cornell's participation in research and engineering phases of the national mobilization program.

Wright was vice-president of engineering, Curtis-Wright Corp., before government service during World War II and became chairman of the Civil Aeronautics Administration in 1944. He went to Cornell in 1948. He is a graduate of Lombard College and Massachusetts Institute of Technology.

JAMES B. KELLEY, formerly director of sales and enginering with The Fawick Airflex Co., Cleveland, Ohio, is now president of the Pneumatic Power Co. in that same city. The company produces rotary air seals, tension control units, and clutch and brake shaft applications.

S. K. WOLCOTT, JR., American-LaFrance-Foamite Corp., Elmira, N. Y., has been transferred from his post as engineer in charge of engines and pumps to assistant manager, Motor Apparatus Sales Engineering. Wolcott, who is a past chairman of the SAE Syracuse Section, also is co-founder of the Seneca Grape Juice Corp., Dundee, N. Y., serving that company in an advisory capacity as a director and vice-president in charge of engineering.

G. J. HAISLMAIER recently joined the Industrial Sales Division of Modine Mfg. Co., Racine, Wis. He previously was affiliated with the Young Radiator Co. as sales manager of its Contract Products Division. Haislmaier was chairman of the SAE Milwaukee Section (1949-50).

Members

JOHN R. HOLLOWELL is now a unit supervisor with the Resident Engineering Group, Ford Motor Co., Cincinnati, Ohio. Prior to this, he was a design analyst with Ford in Dearborn, Mich.

JAMES A. STAHN, previously a sales engineer with Young Radiator Co., Racine, Wis., now holds a similar position with the Air-Maze Corp., Cleveland, Ohio.

PETER J. KRONES is now service engineer with Piasecki Helicopter Corp., Morton, Pa. Prior to this, he was a test engineer with Pratt & Whitney Aircraft Co., East Hartford, Conn.

LLOYD G. LUDWIG, formerly associate research engineer with Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y., is now research engineer "A" in rocket propulsion, Aerophysics Laboratory, North American Aviation, Inc., Downey, Calif.

PHILIP CARD PFISTER, formerly a tutor in mechanical engineering at the College of the City of New York, is now an instructor in mechanical engineering at West Virginia University, College of Engineering.

CARLO RÉ is now chief engineer with Century Engineers, Inc., Burbank, Calif. Prior to this, he was a structures engineer with Fletcher Aviation Corp., Pasadena, Calif.

G. T. M. BEVAN is now vice-president and coordinator of engineering with Massey-Harris Co., Ltd., Toronto, Ont. Prior to this, he was vice-president in charge of engineering and research with that same company.

RAYMOND F. LITTLEY has been promoted to vice-president of the Budd Co., Detroit, Mich. Littley, until recently sales manager of the company's automotive division, will be vice-president in charge of sales of all Budd's automotive products, including automobile component parts, trailers, wheels, hubs and brake drums.

H. BORNSTEIN is now chief technical consultant with Deere and Co., Moline, Ill. Prior to this, he was manager of the materials engineering department with that company.

E. S. EVANS, previously manager of the Pittsburgh district of The California Oil Co., McKees Rocks, Pa., is now sales technical manager of The California Oil Co., Drexel Hill, Pa. He was vice-president of SAE Oregon Section (1944-45).

MALCOLM P. FERGUSON, president of Bendix Aviation Corp., announced last month that Bendix has purchased the Ford Motor Co. plant at Hamilton, Ohio, for the production of aircraft parts and accessories for the armed services.

E. D. KEMBLE has been promoted to manager of manufacturing of General Electric Co.'s Air Conditioning Department, Bloomfield, N. J. In his new capacity Kemble will be responsible for manufacturing operations at the department's automatic heating equipment and air conditioning plants in Bloomfield, and its refrigeration machine equipment plant in Fort Wayne, Ind.

RICHARD D. MAYSTEAD was appointed vice-president and general manager of Pacific Airmotive Corp.'s Manufacturing Division, Burbank, Calif. In 1943, Maystead developed the Pacific Airmotive Corp. government test stand for the Navy, and has specialized in Hamilton-Standard propeller tools over a period of years.

DR. MAURICE NELLES has been appointed director of Borg-Warner Corp.'s Engineering Development Section. Dr. Nelles previously was director of the Engineering Experimental Station and Professor of Engineering Research at The Pennsylvania State College.

HENRY G. TARTER, formerly assistant manager of fuel feed engineering of the Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., has been appointed general manager of the Hamilton Division. Tarter has been associated with the South Bend Division for the past 16 years.

JOHN SASSO, industrial production editor of "Business Week," has joined Fred Wittner Advertising, New York industrial advertising and public relations agency. Before joining the "Business Week" staff in 1946, he was managing editor of "Product Engineering" for a number of years. Sasso is a graduate mechanical engineer with extensive industrial experience. He has authored three technical books and is an active member of The American Ordnance Association, Society of the Plastics Industry, and Society of Plastics Engineers.

JOSEPH GILBERT, recently associate editor, "SAE Journal," became industrial production editor of "Business Week" on February 15. Gilbert joined "SAE Journal" as a technical editor five years ago, shortly after his release from the Army Air Force where he had served as a 1st Lieutenant in the Air Materiel Command. He has participated actively in every phase of SAE publication work and has read several technical papers before Society and outside engineering groups.

SAMUEL J. LORING, consulting engineer, Hamilton Standard Propeller Division of the United Aircraft Corp., East Hartford, Conn., was the recipient of the Melville Medal for 1950 for his paper, "A Theory of the Mechanical Properties of Hot Plastics," which appeared in ASME Transactions.

R. P. KROON was the 1950 recipient of the Spirit of St. Louis Medal for his leadership in the development of the first American design of a turbojet power plant for aviation service. The Spirit of St. Louis Medal was presented to Kroon at the 1950 American Society of Mechanical Engineers Semi-Annual Meeting, St. Louis, Mo.

JOSEPH GESCHELIN, vice-chairman, National Production Activity, was interviewed at Detroit's radio station WJR, and presented a brief summary of the highlights of the technical sessions at the SAE Annual Meeting in Detroit.

ROBERT BOTHFELD, formerly plant layout engineer with the Fisher Body Division, GMC, Euclid, Ohio, is now a buyer in the purchasing department of GMC Truck & Coach Division, Pontiac, Mich.

C. D. LONG is now a design engineer in the aircraft wheel and brake department of Bendix Products Division, Bendix Aviation Corp., South Bend, Ind. He was previously an assistant project engineer with Canadair, Ltd., Montreal, Quebec.

PETER PERISH, formerly senior designer, Pontiac Motor Division, GMC, has transferred to Buick Motor Division, Flint, Mich., in that same capacity.

Correction

JAMES KNOWLES, who, prior to this, was resident engineer with Ford Motor Co. at the Cincinnati plant, is now chief product engineer with the Aircraft Engine Division of Ford in Chicago, Ill. He was on the SAE Detroit Section Membership Committee in 1946.

HERBERT OXLEY, who was supervisor of the dynamometer section of Ford Motor Co.'s Engineering Division, is now experimental department manager in the Product Engineering Office of the Aircraft Engine Division, Chicago, Ill.

Correction

DR. HUGH L. DRYDEN (right) received the 1950 Daniel Guggenheim Medal for "outstanding leadership in aeronautical research and fundamental contributions to aeronautical research". Presentation was made by Lt. Gen. James Doolittle at the Institute of Aeronautical Science's Honors Night Dinner on Jan. 29. The Award is made by a committee of three, of whom one is an SAE representative, and the other two represent the Institute of Aeronautical Sciences and the American Society of Mechanical Engineers.

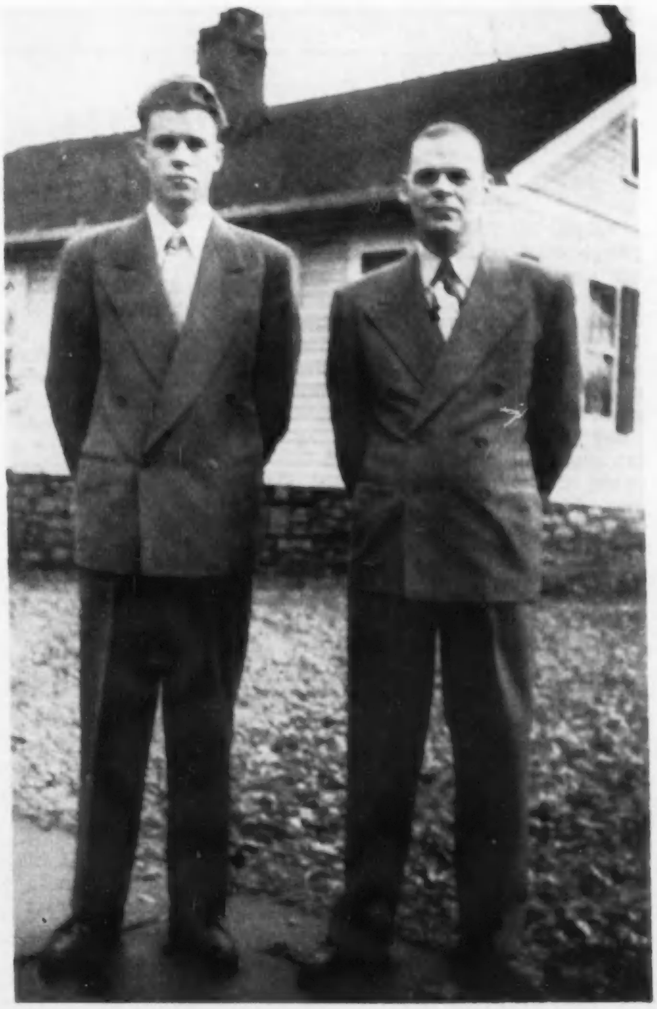
SAE Fathers and Sons

RUDOLPH J. SCHONITZER, JR., left, president and general manager of Pressed Steel Products Co., Cleveland, Ohio, with his father **RUDOLPH I. SCHONITZER**, who owns the Schonitzer Engineering Co., Cleveland. The elder Schonitzer was SAE vice-president representing Body Activity in 1947.

If any SAE reader knows of SAE Father - and - Son combinations, both of whom are members of the Society, your editors would appreciate hearing from you.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated—we don't want to miss any SAE grouping.



JAMES E. EBERHARDT, assistant engineer with the Carter Carburetor Corp., St. Louis, Mo., with his father, **HOWARD EBERHARDT**, an engineering representative of the Carter Carburetor Corp. at the Studebaker Corp.

Students Enter Industry

FRANK O. MANCUSO (Tri-State College '50) to American Locomotive Co., Dunkirk, N. Y.

JACK ALEXANDER SAUNDERS (Northwestern University '50) to General Electric Co., Lynn, Mass.

CARL WILHELM (Indiana Technical College '50) to Fisher Body Division, GMC, St. Louis, Mo.

CHARLES N. RICE (Wayne University '50) to United Engineering & Construction, Inc., Detroit.

JOHN P. MAHONEY, JR., (University of Colorado '50) to Douglas Aircraft Co., Inc., Santa Monica, Calif.

PETER KULKA (Pennsylvania State College '51) to Engineering Experiment Station, Pennsylvania State College.

ARNOLD M. SHANKS (Oregon State College '50) to Aluminum Co. of America, Vancouver, Wash.

HAROLD H. STROEBEL (Case Institute of Technology '50) to Stock Engineering Co., Cleveland.

DONALD R. SMITH (University of Southern California '50) to Refrigeration Engineering Inc., Los Angeles.

DAVID M. MUSSO (Cal-Aero Technical Institute '50) to Wm. R. Whittaker Co., Ltd., Los Angeles.

WILLIAM H. LAWRENCE (Purdue University '50) to A. O. Smith Corp., Milwaukee.

ROBERT EUGENE GUSTAFSON (Northwestern University '49) to Fairbanks, Morse & Co., Beloit, Wis.

HENRY T. JAKUBOWSKI (Indiana Technical College '50) to Bell Aircraft Corp., Buffalo, N. Y.

JOHN S. HAZLEY (Northrop Aeronautical Institute '50) to Piasecki Helicopter Co., Morton, Pa.

EDWARD JAMES FRENS (University of Illinois '50) to Diesel Equipment Division, GMC, Grand Rapids, Mich.

JAMES C. FREWIN (University of Detroit '50) to Babcock & Wilcox Co., Barberton, Ohio.

DAVID SCOTT FISHER (University of British Columbia '50) to Imperial Oil Co., Ltd., Vancouver, B. C.

RALPH T. RUSSELL (Parks College '49) to McDonnell Aircraft Corp., St. Louis.

WALTER GORDON WITBECK (Northrop Aeronautical Institute '50) to Northrop Aircraft, Inc., Hawthorne, Calif.

WILLIAM C. SCHUMACHER, JR., (Northwestern University '50) to International Harvester Co., Melrose Park, Ill.

CHARLES G. HICKS (Wayne University '50) to Kaiser-Frazer Corp., Willow Run, Mich.

RICHARD W. BUBIER (University of Maine '50) to Central Maine Power Co., Augusta, Maine.

ARTHUR K. VIERRA (Cal-Aero Technical Institute '50) to Wm. R. Whittaker Distributing Co., Los Angeles.

JULES J. VAN DEUN (Massachusetts Institute of Technology '50) to Continental Aviation and Engineering Corp., Detroit.

RICHARD E. VALLEY (Indiana Technical College '50) to Allison Division, GMC, Indianapolis.

RICHARD J. WALSH (New York University '50) to Montgomery Ward & Co., New York.

JOSEPH W. WECHSLER (California Institute of Technology '50) to The Rand Corp., Santa Monica, Calif.

BERNARD A. CONRADT (Northrop Aeronautical Institute '50) to North American Aviation, Inc., Los Angeles.

JAMES A. NEESE (Bradley University '50) to Motorola Inc.

JAMES G. DARBY (Michigan College of Mining and Technology '50) to Fairbanks, Morse & Co., Beloit, Wis.

RICHARD THALMAN (Wayne University '50) to Holley Carburetor Co., Detroit.

AUGUST CARL THOMA (Academy of Aeronautics '50) to Aircraft Maintenance International.

FRANK B. SCORE (Indiana Technical College '50) to Thermo Projects, Inc., Elmhurst, N. Y.

Continued on Page 98

OBITUARIES

WALTER H. PEARSON

Walter H. Pearson, an aeronautical power transmission designer, died at his home in Manoa, Pa. He was 50 years old.

Pearson was president and owner of W. H. Pearson and Sons, consulting engineers, Wayne, Pa. He was well known in the bearing, gear, and aircraft industries.

He was a Sunday school superintendent and teacher for the last 25 years, and was recently elected chairman of the Christian Businessman's Committee of the Main Line, Philadelphia. Born in Plainfield, N. J., Pearson was educated at Franklin Institute in Philadelphia.

HAROLD J. KITCHEN

Harold J. Kitchen, director of motor transport of the Bermuda Islands, passed away on December 6, after a short illness. He was 65 years old.

Educated at the Derby College, England, and apprenticed to J. Stone and Co., he joined the Argentine Government Railways in 1905, as assistant to to chief mechanical engineer, Northern Section. Returning to England at the outbreak of the war, Kitchen joined T. Balmforths of Luton, in charge of electric steels for track links of tanks and other warfare materials. Designer of motor rail coaches to Drury Car Co., Ltd., in 1920, he designed the rolling stock for the Bermuda Railway and was appointed chief engineer of this railway in 1930. After its termination, he began his Bermuda Island position.

Kitchen was a keen hobbyist in the horological field and an expert in synchronome astronomical time-keeping instruments of which he made several in his home workshop.

FRED J. SCHAEFER

Fred J. Schaefer passed away on October 5, at the Henry Ford Hospital, Detroit. He was 53 years old.

Schaefer joined Ford Motor Co. in April, 1950, as assistant service manager in charge of technical services. Prior to that time, he had been quality manager and then service manager at Aircooled Motors, Inc. Before going to Aircooled Motors, he was western regional manager of Chevrolet Motors and, prior to that, service engineering manager of Franklin Automobile Co.

He was born in Newark, N. J., and educated at Pratt Institute in Brooklyn, N. Y.

TECHNICAL COMMITTEE *Progress*

SAE Technical Board

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R. P. Lansing
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W. G. Lundquist
M. E. Nuttila
R. J. S. Pigott
H. L. Rittenhouse
E. W. Tanquary
R. R. Teetor
H. T. Youngren

SAE Ride Comfort Researchers Note Man's Vibration Limits

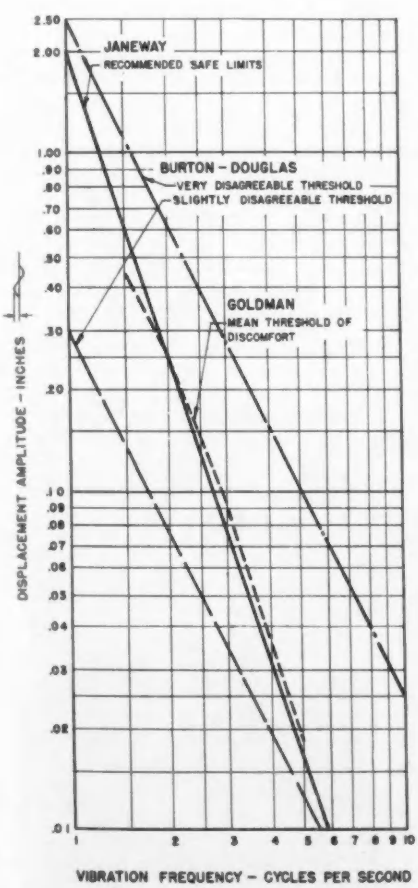


Fig. 1—The passenger discomfort thresholds found for several researchers of riding comfort. Janeway's data apply to passenger cars and railroad trains; the Burton-Douglas curves to aircraft; Goldman's results reflect biological studies

ANOTHER step has been made toward fitting vehicles to passengers by the recently released SAE report, "Ride and Vibration Data," in its second edition. Charts in the book showing human tolerance to vibration make it possible for engineers to interpret vibration measurements in terms of passenger reaction.

You can't set absolute human comfort, or discomfort, standards in physical terms, says the report. But enough data, collected by various investigators, have been pulled together to define a zone outside of which vibration is intolerable.

Fig. 1 compares three independent analyses, detailed in the report. It shows that discomfort is minor above 4 cps. Below that, results differ.

That's partly because dissimilar data were used, and partly because each investigator takes a different viewpoint, based on his particular field of interest. (The Burton-Douglas data reflect conclusions of aircraft engineers; Janeway's recommendations apply to passenger car and railroad practice; and the Goldman presentation represents a broad biological viewpoint.)

Select the chart derived for your particular field of application. That's the suggestion made in the report to engineers who plan to use its data.

The report also deals with simple vibrating systems, acceleration versus static deflection at given amplitudes, relations in simple harmonic motion, natural frequency of a sprung mass, natural frequency versus static deflection, resultant rate of spring combinations, and energy absorption and impact.

A group under the SAE Riding Comfort Research Committee prepared the report. Members of this subcommittee are Maurice Olley, Vauxhall Motors, Ltd.; R. W. Brown, Firestone Tire & Rubber Co.; Henry Fuchs, formerly with General Motors Corp.; R. N. Janeway, Chrysler Corp.; Robert Schilling, General Motors Corp.; and B. E. Sterne, Chrysler Corp. Janeway is chairman of the main committee.

Copies of the report, "Ride and Vibration Data," SP-6, are available from the SAE Special Publications Department. Price: $2.00 to members, $4.00 to nonmembers.

Correction

IN the article "Propose Preferred Number System for Metal and Strip Sheet Gage," by J. Gurski and W. Wiers, on pp. 80, 81 of the January, 1951, SAE Journal, an error was made at the end of the first paragraph in the third column. Reference is made to thickness increments of 0.11 in.; it should be 0.001 in. Sentence should read: "If he does not, Purchasing and Manufacturing may be faced with the problems of procuring, storing, and using a variety of thicknesses which could vary by increments as small as 0.001 in."

SAE Technical Board Approves Committee Personnel Changes

THE SAE Technical Board at its last meeting approved the following appointments:

• E. H. Stilwill, Chrysler Corp., chairman of the SAE Iron & Steel Technical Committee, with H. Bornstein, Deere & Co., as vice-chairman.

• R. G. Cummings, Ford Motor Co., chairman of the SAE Screw Threads Committee.

• E. P. Gohn, Atlantic Refining Co., chairman of the SAE Transportation and Maintenance Committee.

• J. C. Johnson, Pratt & Whitney Aircraft, chairman of the SAE Ignition Research Committee, with T. T. Neill, NACA, as vice-chairman.

• E. G. Schubert, Ford Motor Co., chairman of the SAE Parts and Fittings Committee.

• W. Siler, Delco-Remy Division, GMC, SAE representative on the new ASA Drawings and Symbols Correlating Committee.

• E. P. Lamb, Chrysler Corp., SAE representative on the National Committee on Uniform Traffic Laws and Ordinances, with V. J. Roper, General Electric Co., as alternate.

• K. L. Raymond, GMC Truck and Coach Division, General Motors Corp., as an SAE representative on the Joint SAE-ASTM Technical Committee on Automotive Rubber.

• The following will represent the Society on a subcommittee of the National Committee on Uniform Traffic Laws and Ordinances: R. N. Falge, Guide Lamp Division, GMC; V. J. Roper, General Electric Co.; A. B. Dettmer, Griffin Lamp Co.; P. P. Polko, International Harvester Co.; and B. G. Van Zee, Minneapolis Moline Co. Don Blanchard, secretary of the SAE Technical Board, will serve as secretary of this subcommittee.

• M. H. Young, Wright Aeronautical Corp., as one of the SAE representatives on ASA Sectional Committee Z11—Petroleum Products and Lubricants.

• P. J. Kent, Chrysler Corp., SAE representative on the U. S. National Committee of the International Commission on Illumination. He succeeds J. H. Hunt.

The following changes in the SAE Aeronautics Committee were announced by Chairman R. D. Kelly: W. C. Lawrence, American Airlines, Inc., is vice-chairman, succeeding A. E. Raymond. G. W. Brady, Propeller Division, Curtiss-Wright Corp., is chairman of the SAE Aircraft Propeller Division, succeeding Erle Martin. New members-at-large of the Committee are J. C. Buckwalter, Douglas Aircraft Co., Inc.; C. E. Mines, Allison Division, GMC; and D. F. Warner, Aircraft Gas Turbine Division, General Electric Co.

• Chairman M. D. Gjerde of the SAE Fuels and Lubricants Technical Committee announced the following changes: V. G. Raviolo, Ford Motor Co.; and C. W. Georgi, Quaker State Oil Refining Corp., have been appointed to the F & L Executive Committee. Raviolo has been named vice-chairman of the F & L Technical Committee. New Committee members are: W. B. Davies, Kaiser-Frazer Corp.; C. M. Heinen, Chrysler Corp.; and M. H. Young, Wright Aeronautical Corp.

SAE Renews Interest in Boron-Treated Steels

A NEW division for study and standardization of boron steels has been created by the SAE Iron & Steel Technical Committee.

Committee members anticipate that boron steels will get more serious attention and be more widely used in the light of the current materials emergency. They want to gather as much experience data as possible from users and others familiar with boron needled steels before possibly tackling specification for such steels.

Virtue of boron salts is that they impart the physicals of high alloys to steels, but are inexpensive and plentiful. Wartime investigations showed that boron steels do the job of more costly steels with little or no sacrifice in quality.

A new attitude is said to be growing among steel users and producers toward boron steels. They feel that boron need no longer be considered a special intensifying agent, but can take its

J. C. Johnson, Pratt & Whitney Aircraft (left), recently was appointed chairman of the SAE Ignition Research Committee. T. T. Neill, NACA, is vice-chairman

E. P. Gohn, Atlantic Refining Co., succeeds E. N. Hatch as chairman of the SAE Transportation and Maintenance Technical Committee

ace among other alloying elements ch as nickel, chromium, vanadium, nd molybdenum. If this gains general ceptance, it is anticipated that boron eated steels will be given equal ranking with other alloy types as a standard assification in the steel family.

First job the new group gave itself to dig up all published material bout boron steels. This and reports rom current boron steel users and producers will fortify the members with an up-to-date background on these steels.

This is not the first SAE boron steel program. Committee studies during World War II yielded two SAE boron steel reports. One covered Ordnance steels and the other a program known as the Caterpillar Project, was a study of boron treated steels in production heat size.

Chairman of the new Division is H. B. Knowlton, International Harvester Co.

New Engine Standards Bring Interchangeability

FIVE standards recently completed by the SAE Engine Committee have been approved for publication in the 1951 SAE Handbook. They are:

1. SAE Standard for 0.380 and 0.500-in. V-Belts and Grooves,
2. SAE Recommended Practice for Fan Bolt Circles and Pilot Holes,
3. SAE Standard for Water Thermostat Pockets,
4. SAE Standard for Airflow and Vacuum Governor Flanges, and
5. Revision of SAE Standard for Carburetor Flanges.

The V-belt standard is in line with a trend in industry practice toward narrow sizes—0.380 and 0.500 in. Belt "squeal" elimination and longer belt life are claimed with the new sizes. This proposal was developed by the joint SAE-ASTM Technical Committee A on Automotive Rubber. E. G. Kimmich, Goodyear Tire & Rubber Co., was chairman of this group, which referred its proposal to the SAE Engine Committee for standardization.

Growing demand for greater interchangeability of automotive fans in the field sparked the Practice on fan bolt circle holes. Lack of bolt hole pattern standardization gives suppliers headaches. They find it uneconomical to build and stock the variety of sizes called for by motor vehicle makers.

The new Practice specifies bolt hole circle diameters for these four fan

Continued on Page 102

Technishorts . . . .

POWER TAKE-OFFS: The new SAE Standard for Rear Power Take-Off and Mounting Face on Industrial (Track Type) Tractors is aimed at standardizing mounting facilities and drive connections. Intent of this Standard, developed by the SAE Construction and Industrial Machinery Technical Committee, is to achieve this standardization without hampering design. Included in the Standard are features covering mounting and driving of equipment such as cable power control units, heavy-duty winches, bulldozers, hydraulic units, and separate hydraulic pumps.

SCREW THREADS: An additional section on thread shear area has been approved for the SAE Screw Threads Standard. This new material shows how to determine limiting dimensions of special external and internal threads and gives formulas for the thread shear area.

CAST IRON: A new grade, 53004, has been added to the SAE Pearlitic Malleable Iron Casting Standard. It has a tensile strength of 80,000 psi, a minimum yield point or yield strength of 53,000 psi, a minimum elongation of 4% in 2 in., and a Brinell hardness range of 197 to 241.

WOODRUFF KEYS: A slight change has been made in the keyslot dimensions of the SAE Woodruff Key Standard. Maximum limit for dimension "F" has been increased by 0.003 in Table 2A and by 0.005 in. in Table 2B for all sizes. Purpose of the changes is to give slightly more clearance at the ends of the keyslots for solid and arbor cutters.

TRACTOR FUELS: Definition and specification for farm tractor fuel will be published as general information in the 1951 SAE Handbook. These were developed by a group under ASTM's Committee D-2, at the request of the SAE Tractor Technical Committee, transmitted through the SAE Fuels & Lubricants Technical Committee.

RUBBER MATS: The new SAE Standard for Automotive Rubber Mats specifies general requirements for the material and procedures for testing it. It was developed by the joint SAE-ASTM Technical Committee on Automotive Rubber, and referred to the SAE Non-Metallic Materials Committee for standardization.

EARTHMOVER TIRES: An SAE Recommended Practice will be published in the 1951 SAE Handbook covering haulage tires, grader-tires, and off-highway rims. Prepared by the SAE Construction and Industrial Machinery Technical Committee, this information is intended as a guide for designers in selecting tires.

LIGHTING STANDARDS: Minor revisions have been made to several SAE lighting standards and a new SAE Standard for Sockets Receiving Pre-Focus Base Lamps has been approved. The revisions cover: (1) color test requirements in the SAE Fog Lamp Specification; (2) unit holding ring requirements in the Sealed Beam Headlamp Testing Specifications; (3) the SAE Standard Corrosion Test.

LOCK WASHERS: The SAE Standard for Spring Lock Washers has been made to conform with the newly revised American Standard on Lock Washers, ASA B27.1-1950. New material in both standards includes data on stainless steel, aluminum-zinc alloy, phosphor bronze, silicon bronze, and K-monel lock washers. Also new are dimensional data on internal and external-tooth lock washers, and variations of them. SAE and ASME are cosponsers of the ASA Sectional Committee on Standardization of Plain and Lock Washers.

April 16-19, 1951

SAE National Aeronautic

Monday, April 16

9:00 a.m. Registration Penntop

Registration Fee for Technical Sessions

Members, Applicants, Students, and Service Men ...... No Fee

Other Nonmember Guests $2.00

9:30 a.m. Penntop South

Welcome

M. G. BEARD, General Chairman of Meeting

R. M. HAZEN, Chairman

First Use of Turbosuperchargers in Commercial Aviation
—A. W. WHITE, E. O. HENRICKSON, and F. W. FERNALD, General Electric Co.

Surging in Centrifugal and Axial Flow Compressors
—R. O. BULLOCK and H. B. FINGER, National Advisory Committee for Aeronautics

Influence of Turbine Engines on Transport Operating Costs
—J. G. BORGER and R. W. BLAKE, Pan American World Airways

(Sponsored by Aircraft Powerplant Activity)

2:00 p.m. Penntop South

CAPT. C. H. SCHILDHAUER, Chairman

Symposium—Latest Developments in Flying Boats
—J. D. PIERSON, The Glenn L. Martin Co.
—E. G. STOUT, Consolidated Vultee Aircraft Corp.
—CAPTAIN D. B. MacDIARMID, U. S. Coast Guard Air Station, San Diego
(Sponsored by Aircraft Activity)

8:00 p.m. Penntop South

CHARLES FROESCH, Chairman

Treatise on Experience—Review of Transport Aircraft Detail Design Difficulties and Their Remedies
—W. W. DAVIES, United Air Lines, Inc.
(Sponsored by Air Transport Activity)

Tuesday, April 17

All Day Panel—Local Service Air Transportation

Chairman

R. DIXON SPEAS

A. V. Roe Canada Ltd.

(Sponsored by Air Transport Activity with the cooperation of Aircraft and Aircraft Powerplant Activities)

9:30 a.m. Penntop South

R. E. PEACH, Chairman

Wanted—A New Airplane
—T. H. DAVIS, Piedmont Airlines

Operating Cost Characteristics of Local Air Service Operations
—C. W. WENDT, All American Airways

Passenger and Cargo Service Standards Required for Local Air Service
—MEL ANDERSON, Lake Central Airlines

2:00 p.m. Penntop South

JOSEPH GARSIDE, Chairman

Aircraft Ground Handling Characteristics as Required for Maximum Efficiency
—J. G. RAY, Ray and Ray—Airline Consultants

Local Service Aircraft and Engine Maintenance Requirements
—CHARLES L. BAKER, Trans-Texas Airways

8:00 p.m. Penntop South

F. S. GLASS, Chairman

Helicopters Applied to Local Air Service Operation—American Plan
—C. M. BELINN, Los Angeles Airways, Inc.

Hotel Statler
New York City

Meeting

and Aircraft Engineering Display

Helicopters Applied to Local Air Service Operation—British Experience and Requirements
—N. E. ROWE, British European Airways

"Little Henry"—color motion picture
—Commentary by R. R. OSBORN, McDonnell Aircraft Corp.

Wednesday, April 18

9:30 a.m. Penntop South

J. B. FRANKLIN, Chairman
Flight Experience with U. S. Turbine Powered Aircraft

Flight Experience with Turbine Propeller Powered Aircraft
—R. C. LOOMIS and E. D. SHANNON, Consolidated Vultee Aircraft Corp.

Flight Characteristics of the B-47
—R. M. ROBBINS and W. H. COOK, Boeing Airplane Co.

Operational Experiences with Multi-Engine Jet Aircraft
—N. N. DAVIS and E. M. BEATTIE,

"Britain's Newest Aircraft"
Motion picture presenting highlights of SBAC Show at Farnsborough, England, September 1950

(Sponsored by Aircraft Activity)

2:00 p.m. Penntop South

R. L. ANDERSON, Chairman

Flight Research Experience with Higher Aircraft Engine Oil Temperature
—D. N. HARRIS, F. R. WATSON, T. FRAME-THOMSON, and D. C. McMACKEN, Shell Oil Co.

Airline Experience with Engine Lubricating Oils
—H. N. TAYLOR, United Air Lines, Inc.

(Sponsored by Aircraft Powerplant Activity)

DINNER

7:00 p.m. Penntop

E. N. HATCH
Chairman
SAE Metropolitan Section
Toastmaster
CASEY JONES
President, Academy of Aeronautics
Presentation of Wright Brothers Award
to **J. C. FLOYD**, A. V. Roe Canada Ltd.,
by **A. E. RAYMOND**, Chairman,
Wright Brothers Board of Award
DALE ROEDER
SAE President
Principal Speaker—
GILL ROBB WILSON
Aviation Editor, New York Herald Tribune

Thursday, April 19

Aircraft Display and Demonstration

New York International (Idlewild) Airport

(Courtesy U. S. Air Force, Navy Bureau of Aeronautics, Office of Naval Research, Royal Canadian Air Force, Port of New York Authority, and various companies contributing exhibits.)

Advanced designs of jet bombers, fighters, and transports; Navy "Skyhook-type" balloon mistaken for flying saucers; and helicopter demonstrations.

Buses leave from 32nd Street Entrance of Hotel Statler at 9:00 a.m. Round Trip Bus Fare—$2.25.

Buffet Lunch—Dobbs House, Idlewild Airport Terminal 11:30 a.m.-1:00 p.m. —$1.50 per plate.

SAE Student News

Wayne University

Students here were treated to a step-by-step description of the development of the disc-type brake as recently placed in production by Chrysler Corp., when Paul Sturm of Chrysler engineering spoke to the Wayne student group on Dec. 7. Sturm used slides of previous models to show the development of the idea from the earliest types and pointed out their shortcomings. He showed how trends toward heavier vehicle weights, smaller outside wheel diameters, and wider tires, were rapidly rendering the drum brake inadequate both from the standpoint of braking surface area and heat dissipation characteristics. Those interested in product development were surprised to hear that the entire project, from the first order for development of a disc-type brake, to the first production installation, was completed in approximately three months. Numerous curves were shown illustrating the brake effectiveness and fading characteristics of the disc brake as compared to the drum-type. After his talk the center of attention was an operating cutaway model of the Chrysler brake which cleared up any remaining doubts as to its functioning.

—David Crockett

Loyola University

Bill Krainok, field service representative of GMC's Allison Division, was guest speaker at the Jan. 10 banquet meeting of the Loyola SAE Student Branch. Recently returned from the Korean war zone, Krainok reported on American jet aircraft and their combat operation. Over 50 student engineers and guests present got first hand information on the war in general and jet operation in particular.

—John N. Van Dusen

University of Washington

Joseph Testu, Kenworth Motor Truck Co., is optimistic about the future of the gas-turbine-powered motor truck, he revealed in a talk here on January 9. Testu based his thinking on Kenworth's experimental experience in adapting a gas turbine to truck operation. He told the SAE Club many details of the conception of the joint Kenworth-Navy project on the gas turbine truck adaptation and reported on its present progress. The basic problem, he said, has been to utilize efficiently the weight advantages that are inherent in the gas-turbine truck. The turbine, he pointed out, has only 8.5% of the component parts of a conventional piston-engine of equivalent horsepower.

At an SAE Club meeting last November 14, Glenn Grant of Ethyl Corp. was the chief speaker; and on November 21 a joint meeting with the ASME student chapter featured a motion picture showing the development of the Boeing gas turbine.

—Robert Hawkes, Field Editor

New York University

Seventy-five students were present at the Dec. 7 meeting of NYU's SAE Student Branch to hear Merrill C. Horine discuss automatic transmissions. Horine, who is sales promotion manager for Mack Mfg. Corp. and a past vice-president of SAE, exhibited a true spark of showmanship by using two electric fans and a grapefruit to illustrate the principles of fluid drive couplings. Following this was an explanation of the lever action within the torque converter which distinguishes it from other fluid drive couplings.

Slides were shown illustrating the application of fluid couplings and torque converters to passenger and commercial vehicles, in the form of automatic transmissions. Chrysler's transmission was described as a semi-automatic transmission in conjunction with a fluid coupling, and was called the "grand-daddy of fluid drive transmissions." General Motors' Hydra-Matic is a fluid coupling combined with planetary gears. The device contains a complex arrangement of brake bands and disc clutches that shift the transmission automatically.

The Buick Dynaflow and Chevrolet Power-Glide contain five sets of blades that comprise a polyphase torque converter used with a planetary gear set. However, both have single-stage turbines in contrast to the Packard Ultramatic, which has a two-stage turbine.

The three-stage torque converter, as used on buses with no mechanical change gears for forward speeds, also was described. The torque converter is used for its most efficient range (for pick-up and acceleration.) At normal speeds, direct drive takes over.

During the question-and-answer period, Horine pointed out that the heat generated in the clutch and gears of a conventional transmission may at times be as great as that in the hydraulic type of drive. It was also noted that many drivers do not get good mileage with hydraulic transmissions because they tramp on the accelerator rather than gradually applying pressure to get the best results and highest efficiency

A torque converter, Horine pointed out, always provides the proper relation of torque and acceleration automatically. "It is one of the things that think better than the driver."

—Stanley R. Spector

Bradley University

Members present at the Bradley SAE Student Branch meeting on Jan. 9 heard L. Scott of the government sales department of R. G. LeTourneau Co. discuss the newly-developed "Tournatow."

Scott said the development of jet bombers such as the B-47 produced need for a machine to tow these planes to the end of the runway, since large amounts of fuel are required to taxi jet airplanes. The Tournatow has diesel-electric drive and is mounted on rubber tires. A military standard GM-6-71 diesel serves as powerplant and is coupled to a d.c. dynamo and an alternator. The d.c. generator supplies current to the four driving motors located in the wheels of the Tournatow. Each wheel is driven by a separate motor through reduction gears in the wheel assembly. The output of the d.c. generator, and hence the speed of the vehicle, is controlled by varying the field current of the generator with a potentiometer.

The a.c. generator supplies current to the two steering motors and the winch motor. This alternating current arrangement has been proved on heavy construction equipment produced by LeTourneau. Steering is accomplished by turning front wheels, rear wheels, or both. This makes oblique movement of the machine possible. When power to any motor is shut off, a brake is applied. Brakes are released by electromagnets when power is again supplied to the motor.

As designed, the maximum drawbar pull with Tournatow is limited by weight. Additional drawbar pull may be secured without mechanical failure of the machine by adding weight. Besides extremely smooth starting ability, Scott said, the Tournatow features simplicity of operation and the elimination of many moving parts.

—Robert H. Smith, Field Editor

SAE Section Meetings

)escribes Results Of Dust Tunnel Tests

• Metropolitan Section
C. F. Foell, Field Editor

Feb. 1—This Section was treated to a first-hand report of the Fram dust-tunnel initial tests by **William S. James,** vice-president of engineering and research for Fram Corp.

Tests are conducted in a building designed exclusively for the purpose. The tunnel proper is an aluminum-lined room 50 ft long by 15 ft wide by 14 ft high, and equipped with a 200,000 cfm blower driven by the car being tested. The arrangement is similar to the normal dynamometer set-up, with the blower replacing the dynamometer. Dust concentration is electrically measured and controlled. The amount of dust employed usually is 0.0125 gm per cu ft of air. A variety of apparatus is used to determine and segregate particles by size, thus giving another variable useful in the test work.

Primary function of the dust tests is to determine the dust-retarding values of the engine protective components, although useful information is also being amassed on the dust sensitivity of other parts such as spark plugs, carburetors, distributors and similar items. Determination of wear of parts such as cylinders, pistons and rings is not of first interest as such, although it does serve as the chief measure of the dust-retarding properties of carburetor air cleaners, breather cap cleaners and oil filters. Accessory means are determination of bearing oil leakage and total drop in oil pressure throughout the entire oiling system.

Test conditions are made as strenuous as possible, with heavy dust concentration and high car speeds. Most tests to date have not exceeded 2 hr duration, with shut-downs made necessary by excessive blowby (8 cu ft per min is the upper limit allowed), loss in compression pressure or drop in power excessive bearing noise, or clogged carburetor jets; as might be expected, an air cleaner rarely goes through a complete cycle without cleaning due to the rapidity with which it becomes loaded at the high dust concentration used.

Some of the more important preliminary conclusions cited by James may be summarized as follows:

1. There is a wide difference in the efficiency, that is, dust-retarding properties of wetted-element, oil-bath and adhesive type air cleaners.
2. Within any type, there may be wide differences in efficiency among various makes.
3. Dust under 5 microns size produced the greatest amount of abrasive wear of engine components.
4. The influence of the carburetor air cleaner is most apparent on the rate of ring wear.
5. The influence of the lubricating oil filter is most apparent on the rate of bearing wear and journal wear.
6. If the combustion-air induction system can be made and kept really effective with respect to barring the entry of dust into the engine, abrasive wear rate in an engine may be reduced to a very low value.

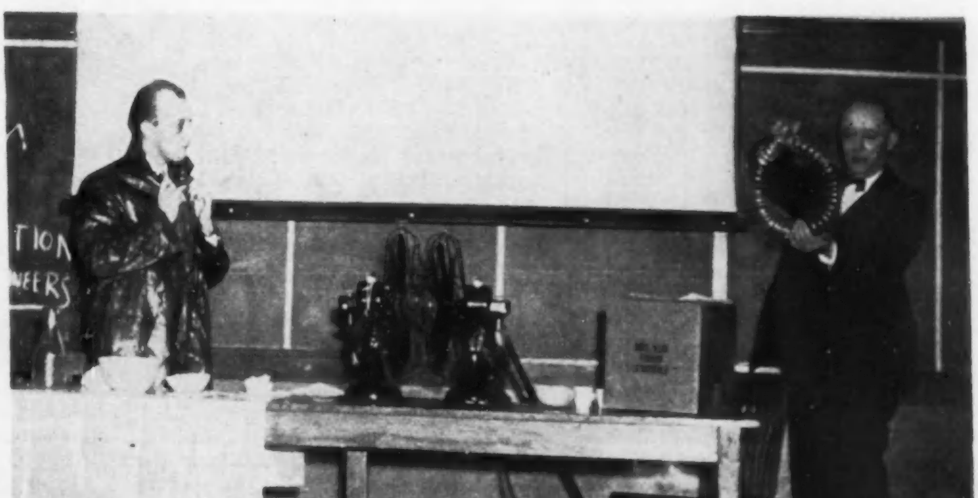
This meeting was arranged for and conducted by Robert Gardner, vice-chairman of Metropolitan Section's T & M activity.

B. C. Loggers Meeting Problems Successfully

• British Columbia Section
J. B. Tompkins, Field Editor

Jan. 15—Constantly seeking lower transportation costs, British Columbia's loggers (and log contract haulers) are successfully meeting the problems of longer hauls under sometimes severe grade, contour and weather conditions and "transition from the desolation of our forests to present-day selective logging."

This was the message brought by **M. A. Larsen,** Seattle off-highway-truck factory representative of Mack Motor Truck Corp. of New York. He said that experience has shown that "larger trucks, with bigger tires, more



Merrill Horine (right), speaker at NYU's Dec. 7 meeting, illustrates the flow of fluid in a torque converter by use of helical springs with the ends placed together. At the left, Douglas Raymond stands before the grapefruit and two fans used in the demonstration

You'll be interested to know . . . .

NEW PRESIDENT OF THE COORDINATING RESEARCH COUNCIL is C. E. Frudden, a past-president of SAE and consulting engineer, Allis-Chalmers. CRC vice-president for 1951 is W. J. Sweeney, Standard Oil Development Co. . . . Frudden has been a member of the CRC Board of Directors and has just been reelected for the 1951-52 term. Other SAE representatives re-elected for this 1951-52 term are W. G. Lundquist of Wright Aeronautical and E. S. MacPherson of Ford.

SAE representatives completing the second year of their 1950-51 term as CRC Directors are: E. N. Cole of Cadillac, G. J. Huebner of Chrysler, and R. D. Kelly of United Air Lines.

MUIR L. FREY OF ALLIS-CHALMERS MFG. CO. will be general chairman of the Production Forum scheduled in connection with the SAE National Tractor Meeting in Milwaukee next fall. The Forum will be held Sept. 10 and the Tractor Meeting on Sept. 11-13.

ENROLLED STUDENTS WON'T LOSE THE PRIVILEGE of becoming SAE members without paying initiation fees just because they get pulled into military service before they complete joining SAE. Council took care of that at its last meeting. . . . Now an Enrolled Student who has been elected to membership but enters U. S. or Canadian armed forces before completing his election still will have his initiation fee waived if he takes up his membership within one year after he gets out. . . . Same proviso applies to Enrolled Students who get into military service while in good standing as Enrolled Students.

STUDENT BRANCH CHARTERS HAVE BEEN granted to the SAE Student Group at Wayne University, Detroit, and to the SAE Student Group at Michigan State College at Lansing. . . . This brings the total of SAE Student Branches to 35.

HERBERT HAPPERSBERG has been reappointed as SAE representative at the Annual Safety Convention and Exposition, to be held April 3-6 at the Hotels Statler and Governor Clinton in New York City.

powerful engines, more rugged driving and chassis parts, more adequate brakes and specialized transmissions were required and that the price of such equipment was considerably higher than for lighter vehicles."

But, he quickly added, in delivering a paper originally scheduled for presentation to the B. C. Section by Sales Training Manager Merrill C. Horine, experience also proved that "only trucks with sufficient inbuilt stamina, power and ratio range could withstand the rigors of logging service. At the same time it soon became apparent that the larger loads which these bigger trucks hauled meant lower cost of transportation per 1000 feet."

Using slides to point up the salient points in the Horine-prepared paper entitled "The Truck's Part in Logging Conservation," pinch-hitter Larsen traced the development of the modern logging unit from the conventional four-wheeled tractor and two-wheeled trailer to present super-duty off-highway giants.

Emphasizing that major gains in economy must come from exceeding "limitations of legal width and weight," Larsen pointed out that such equipment "by reason of their ponderousness may be operated only upon private roads." A number of large log operators have found it economical to construct and maintain private roads, he said, paralleling public highways "for the sake of the economy realized from the greater capacity of these super-duty vehicles and their ability to stand up under the severe demands made upon them."

But capacity alone, the astronomical loads possible by the huge off-highway units, is "alone not sufficient for economy," he told the SAE members and guests.

"Performance, in terms of average running speed under the conditions imposed by the nature of the terrain, road surface and weather conditions, is equally important," Larsen said. "A doubling of capacity with a corresponding reduction of running time, would offer no gain whatever. In fact, it is logical to suppose that such an operation would actually cost more per 1000 ft than a more normal rig. But, if the increase in capacity can be achieved while retaining the same performance ability, and if the vehicle making this possible is soundly constructed so that it preserves a high degree of reliability, stamina and economy of maintenance, then an important saving of unit cost can most certainly be expected."

Fuel economy drew the Horine-Larsen spotlight. Cheap grades of gasoline were quickly shelved as "disastrously expensive." Diesel, even if purchased at the same price per gallon as gasoline, offers "startling economy in fuel cost per mile or hour of operation due entirely to its higher thermal efficiency." Compared with gasoline, the diesel delivers from 50 to 75% more thermal efficiency.

Section Is Host To Seven Colleges

• Philadelphia Section

M. A. Hutelmyer, Field Editor

Jan. 10—At this meeting Philadelphia Section was host to 85 students from the engineering classes of Drexel Institute. University of Pennsylvania, University of Delaware, and Haverford, Pennsylvania Military, Swarthmore, and Villanova Colleges.

The meeting was arranged to interest the students in SAE and the advantages they would receive by joining the Society. Success of the meeting can be best measured by the 49 inquiries for further information concerning the Society, which have been received from the students present.

Technical Chairman Prof. Ted Hetzel of Haverford College set the keynote for the evening with a review of last year's talk: "After Graduation—What?" He then introduced the speaker, **Chaplin Tyler** of E. I. duPont de Nemours & Co., whose subject was "Are you of Executive Caliber?"

Tyler's paper grew from an analysis of a number of prominent executives

with whom he had ben associated over a period of 30 years, to determine what broad characteristics they had in common.

From this examination emerged three characteristics:

1. Energy or drive. This characteristic is manifested in great capacity for work, coupled with constructive direction of personal effort. This characteristic might also be called "the will to do" and is infectious, as it tends to impel or motivate effort in others.

2. Effective intelligence. Because an executive spends so much time working with people, there is a tendency to overlook his role as a thinker. A good executive possesses more than intellect: he has an inquiring mind, continually seeks better ways and means of doing things, and has ability to express ideas clearly and fluently. He is intellectually honest, and thinks straight. He will be particularly wary of high-spot or superficial investigation. Thoroughness is the watchword, even at the expense of valuable time.

3. Effective relationships with people. From the executive viewpoint, people fall into three groups: superiors, associates and subordinates. The man of executive caliber strives to have equally good relationships with all three groups. From superiors he takes orders and accepts constructive criticism without resentment. With associates he is unstintingly collaborative. With subordinates he strives to evoke cooperative effort rather than to impose authority. True executives are masters of the art of leading by example. All are approachable and all

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SAE Central Illinois Section's EARTHMOVING INDUSTRY CONFERENCE

Hotel Pere Marquette, Peoria, Ill. **April 10-11, 1951**

TUESDAY, APRIL 10

8:00 a.m.
No Registration Fee
Registration

9:30 a.m.
Welcome
J. P. CARROLL
General Chairman of Meeting

Keynote Address
C. G. A. ROSEN
Consulting Engineer, Caterpillar Tractor Co.

H. L. RITTENHOUSE, Chairman
Heavy-Duty Brake Requirements of Rubber Tired Earthmoving Equipment
—R. K. SUPER, Timken-Detroit Axle Co.

2:00 p.m.
R. A. FLETCHER, Chairman
Soil Mechanics and Earthmoving Equipment Design
—M. G. SPANGLER, Iowa State College, and W. S. POLLARD, University of Illinois

6:30 p.m.
BANQUET
Feature Speaker
KENNETH McFARLAND
Superintendent of Schools, Topeka, Kans.
Consultant to GMC and
Readers Digest Magazine

Toastmaster
J. G. FINDEISEN
Chairman, Central Illinois Section

WEDNESDAY, APRIL 11

9:00 p.m.
F. A. GROSS, Chairman
Tire and Rim Development for Earthmoving Equipment
—W. I. FORD, U. S. Rubber Co., R. D. EVANS, Goodyear Tire & Rubber Co., L. W. FOX, Firestone Tire & Rubber Co., and R. V. SNYDER, B. F. Goodrich Co.

1:00 p.m.
R. D. EVANS, Chairman
How Machines Are Selected and Methods Established for Earthmoving Contracts
—E. H. HONNEN, McCoy Co., and M. C. HARRISON, Harrison Construction Co.

Members of the 1951 SAE Earthmoving Industry Conference Committee meet to discuss plans for forthcoming meetings to be held in Peoria on April 10-11. Shown left to right at committee planning meeting are: Roger Smith, program; Robert Mills, secretary; Harlow Piper, arrangements; John Carroll, general chairman; Woodrow Kimsey, vendors' activities; and Walter McCulla, treasurer

Journal Index Available

A complete Index covering the twelve 1950 issues (Vol. 58) of the SAE Journal is now available to members and subscribers free upon request.

are good listeners.

Tyler said that where the above characteristics, properly balanced, are present, the top executive will be found.

In conclusion he posed the question: "Are You of Executive Caliber?" to his audience. He asked the following questions: "Do people look to you to get things done?" "Are you in demand to head committees, or do you sit tight and let the other fellow carry the ball?" "Are you called upon frequently to analyze tough problems, or are you asked to merely contribute data?" "Do you jump at the chance to give an associate a lift, and do others jump at the chance to give you a lift?" In brief, "Do you have the will to do; do you think straight, and do your actions evoke cooperative effort?"

British Visitor Reports on Jets

• San Diego Section

Charles F. Derbyshire, Field Editor

Feb. 6—The United Kingdom is committed, almost entirely, to development of jet powered aircraft, according to **Kenneth C. Hunt,** technical manager of the Anglo American Oil Co. of England. Most promise seems to lie in direction of axial flow compressor types, with considerable to be done in the way of lowering specific fuel consumption. American piston engines continue to hold a high position as prime movers for commercial transport aircraft the world over. It is to be expected, however, that U. K. concentration on jet development for military aircraft will result in significant strides in this field as applied to commercial aviation.

Fuel sensitivity for gas turbines should be reduced. Future for synthetic lubricants appears promising.

Discussion by Robert E. Day, experimental engineer, Solar Aircraft Co., covered the desirability of an ideal fuel for after-burner application, although it was admittedly a complex matter to carry two kinds of fuel on one aircraft. Hunt stressed the possibility that a fuel ideal both for gas turbine and after burner was a possibility.

Use of Propane Still Limited

• Mohawk-Hudson Group

Frank Baker, Field Editor

Jan. 17—"Diesel versus Propane Powered Equipment" was discussed at this meeting by L. Raymond, staff assistant of Socony-Vacuum Laboratories, in terms of physical properties availability, and cost.

Propane is a secondary fuel, he said, that has been used so far in engines that have been primarily designed as gasoline engines but which have been modified to use propane. Availability and proximity of the source of supply to the consumer has been a vital factor in its use. Where it is readily procured at a low cost, it can be used competitively against gasoline and diesel fuel. In other locales, initial engine modification costs, storage, and transportation problems increase its cost to a point of impracticability.

In the last analysis, Raymond said the future of propane as a fuel depends on engine developments and the economics of the oil industry. (This paper was originally presented at the 1950 SAE Fuels & Lubricants Meeting.)

Tells Weather's Part In Automobile Design

• Mid-Michigan Section

E. H. Holtzkemper, Field Editor

Jan. 22—Weather has had a major influence on car design, according to **K. E. Coppock,** assistant chief engineer of Fisher Body Division, GMC.

The first cars were built as simply as possible and did not provide any protection for occupants against sun, rain and cold. They were also built high to provide maximum "wading depth" for muddy roads created by rain. However, as cars became more widely used weather protection became important. Windshields, tops and side curtains were added—first as extra cost items and later as standard equipment. Then as the mechanical reliability of the car improved they began to be operated in winter, and the open cars were fitted with California tops to give passengers further protection. Exhaust system heaters were introduced with the tops as the primitive beginning of providing passenger warmth. The expensive removable tops were then followed by factory built closed cars. Their popularity has steadily increased until today more than one-half of all cars built are 4-door sedans and two-fifths of all cars built are 2-door closed models.

The continuous improvement of roads over the years has reduced the effect water, or gasoline combustion type,

Shown at San Diego Section's Feb. 6 meeting are (left to right): William Ring, Dwight Moore, Herbert Sharp, and Frank Fink, of Consolidated Vultee Aircraft Corp.; Speaker Kenneth C. Hunt; Chairman William C. Heath; W. W. White, Esso Export Corp.; O. B. Lyons, Standard Oil Co. of Calif.; C. S. Brandt, Consolidated Vultee; and C. D. Elliot, Esso Export

rain and permitted use of smaller diameter tires and lower overall car height.

The modern closed car has easily adjustable windows and venti-panes to provide passengers with the desired amount of air flow in summer. Today, heaters of either the exhaust, hot provide uniform warm air for passenger comfort and window defrosting and deicing. The next step forward will be to provide temperature control of car air in warm weather. Simple water evaporation systems are now extensively used in the dry hot western states. For use in other sections of the country, satisfactory systems having a refrigeration capacity of 1 to 1-½ tons of ice per hour have been developed. However, their introduction will probably be postponed due to the present national emergency.

Thus the automotive engineer has progressed in his battle with weather to the point where the automobile has actually became a comfortable living room on wheels.

Propane Getting Increased Interest

• Pittsburgh Section
H. K. Siefers, Field Editor

Jan. 23—Propane, as a fuel for automotive vehicles, has been attracting considerable interest in recent months in the bus industry, stated **Leonard Raymond** of the research & development department of Socony-Vacuum Oil Co. in his recent paper "Liquefied Petroleum Gas as a Fuel for Automotive Vehicles."

Raymond attributed this interest to (1) rising operating costs in the bus industry (2) the increased supply of propane (3) the availability of engines of higher compression ratio.

He described the sources, properties, and demand and availability of propane and described the equipment required for its transportation, handling, dispensing and use.

The potential availability of propane, he said, far exceeds the expected demand for some years to come. No fundamental technical difficulties appear in the automotive use of propane and higher compression-ratio engines equalize fuel consumption in miles per gallon with propane and gasoline.

Picturing the economics of engine operation on propane as compared to gasoline and diesel fuel, Raymond stated that the costs of installation of engine, storage and dispensing equipment is considerably greater for propane, while the differential in fuel costs

25 Years Ago

Facts and Opinions from SAE Journal of March 1926

The total number on the rolls of the Society as of Feb. 15, 1926 was 5799. Of these, 4608 are located in 11 states — Michigan, New York, Ohio, Illinois, Pennsylvania, Indiana, California, New Jersey, Massachusetts, Wisconsin, and Connecticut. Michigan has 1023 members—Connecticut 127.

■

A Sections Committee draft of proposed revisions to the standard Section Constitution would delete the provision that in all cases of order preference will be given to written over oral discussion "as contributing to the greater clarity, pertinence, and value of the record." The Sections Committee doesn't think this is always the case. Thinks decision should be at discretion of the chairman.

■

For good engine life, said L. P. Kalb to the Metropolitan Section, the sustained speed of interurban coach engines should not exceed 1800 rpm, and for a sustained vehicle speed of 45 mph, the gear ratio should be approximately 4¼ to 1 with 36-in. tires. It is desirable to govern the engine speed, he said—and that a large engine running at 1800 rpm is preferable to a small high-speed engine, but extreme care must be exercised to keep the weight down.

■

E. W. Templin, of the Six Wheel Co., says that balloon tires are coming into the picture for interurban bus operations, and that tandem rear-wheel arrangement is proper for application of the tires and is proving economical.

■

A trend toward lower chassis and bodies and to adjustable driving seats was predicted by Herbert Chase, of Erickson Co., at a Cleveland Section meeting. Better heating and ventilating are needed, he said, and windshields should be easier to adjust. Four-wheel brakes, eight-in-line engines, balloon tires, and better chassis lubrication have won popular approval, he stated.

■

Street cars operating on rails in the middle of the street must be eliminated, A. W. S. Herrington said in a paper on traffic congestion read at a Milwaukee Section meeting.

■

"One of the most interested listeners to a paper by Pulitzer Air Race winner Lt. Cyrus Bettis at the Detroit Section meeting was 13-year old Frank Rippingille, son of E. V. Rippingille. The boy already has some 15 hr of flying time to his credit, a goodly percentage of which is solo flying."

■

"The almost universal adoption of the flat-rate system has supplied the force to compel consideration of accessibility and ease of servicing." B. C. Hinckly on "Design Standardization for Simplified Service."

■

The production of gasoline by cracking is increasing more rapidly than total production and in 1927 may equal the production of uncracked gasoline, according to J. B. Hill and T. G. Delbridge of Atlantic Refining Co.

■

"The drawbacks of gasoline made by the cracking process, from the point of view of the refiner, have been color, odor, and inability to treat it chemically without an abnormal loss. However, all these difficulties have been solved, and gasoline derived by the cracking process stands today as a most satisfactory motor fuel."—R. F. Lybeck, Beacon Oil Co., in paper, "Present Day Automotive Fuel."

Section Officer Changes

Frank Baker, American Locomotive Co., is now chairman of Mohawk-Hudson Group. Donald C. Peroutky of General Electric Co. succeeds him as field editor.

C. E. Steed, of Motor Convoy, Inc., is membership chairman for Atlanta Group. He succeeds J. G. Loudermilk, who returned to the Armed Forces.

and maintenance expenditures favor propane.

In some localities the storage, transportation and use of propane is prohibited from a safety standpoint, he said, but with satisfactory equipment and care the safety record could probably equal that of gasoline.

The discussion period revealed considerable interest by local fleet operators in the possibilities of LP gas. However, there are no users of this fuel in the Pittsburgh district. C. J. Livingstone of Gulf Oil Corp. participated actively in the discussion.

British Jet Engine Developments Reported

• Metropolitan Section

Charles F. Foell, Field Editor

Jan. 4—Although petroleum technologists and jet engine designers have basic differences of opinion about the optimum jet engine fuel of the future, agreement was reached here tonight that:

Availability will determine the specification in case of a national emergency; and

Kerosenes, in view of both laboratory and flight tests, leave little to be desired and in some quarters have strong support as jet fuels.

Kenneth C. Hunt, Anglo-American Oil Co., came from England to give Metropolitan Section members and their guests a review and an outlook of jet engine and fuel developments in that country.

Because of the newness of the jet powerplant and the rapid strides in improved materials to withstand the high temperatures and pressures, too little is now known of the characteristics of the engine of the future to form dogmatic opinions of fuels for that engine. So said Hunt, **Edwin A. Droegemueller**, Pratt & Whitney Aircraft, and **Hugh Harvey**, Shell Oil Co., the other speakers.

The Briton startled some of his audience with the prediction that within seven years the demand for jet fuel will be several times greater than that for aviation grades of gasoline for reciprocating aircraft powerplants.

In general jet fuels must be: stable under all conditions of temperature and flight; protected against loss in tankage and through pumps; and available in adequate quantities and at a reasonable price.

Hunt suggested that a low-freezing point kerosene-type fuel satisfied both engine and aircraft requirements and that supplies should be extended in an emergency by increasing the volatility to a maximum of 2 lb Reid vapor pressure.

Navy and USAF spokesmen pointed out that, in a shooting war, availability of jet fuel might determine its specification. Both hoped that the intense development work on the powerplants themselves and on new fuels would continue without abatement.

Hunt, who began his engineering career in the aircraft and powerplant

fields, showed the development of the jet engine from its inception and explained those powerplant layouts which the industry in Great Britain expect to be incorporated in the jet engine of the future.

Speakers brought out the troubles encountered by fuel deposits on the burner, its nozzle and on the blading of the rotors.

Chairman of the meeting was Neil P. Flynn, Standard Oil Co. (New Jersey), Met Section vice-chairman for Fuels & Lubricants.

Section Visits Trailmobile Plant

• Cincinnati Section
Walter Walkenhorst, Jr., Field Editor

Jan. 25—Design and manufacturing features of trailer construction were the main points of interest when 135 members and visitors of this Section were guests of the Trailmobile Co. for dinner and a plant tour.

They visited, in small groups of six or seven, the small-parts-fabrication department; sub-assembly; machine shop; insulating and special body work; and final assembly.

Performance Requires Proper Equipment

• Southern California Section
R. E. Strasser, Field Editor

Jan. 18—Unless the proper type of power application has been made, the chances of a vehicle's performing satisfactorily and economically are quite remote, said **Harold H. Hall**, general service manager, Cummins Engine Co., Inc. Correct power means application of the horsepower and the engine required for the desired performance, and the most efficient usage of this engine and horsepower. This will include the correct selection of transmission, auxiliary transmission, rear axle, and tire size. In order to obtain the maximum horsepower output of any engine, it is necessary that the engine be operated at maximum governed rpm. The term "lugging," frequently used when speaking of engine rpm, was defined as operating below the governed speed with full throttle applied. It is realized there are times when engine speed will be pulled down 100 to 200 rpm, but the engine is lugging when engine speed is pulled down more than 300 rpm. All engine manufacturers disapprove of lugging an engine because this type of operation causes increased pressures within the cylinders, increased loads upon internal engine parts, and increased heat which has to be dissipated. In order to operate an engine at governed rpm, it is necessary to select the proper equipment for the engine. To make the proper selection of equipment for any job, it becomes necessary to analyze the conditions under which it will operate and then select the combination which will do the job most efficiently. Hall concluded by stating that he knew of no better way to do this other than plotting the performance requirements and performance ability on a graph. In order that the best selection be made, graphs of several combinations might be required.

Expert Discusses Engine-Fuel Problems

• Buffalo Section
D. C. Appelby, Field Editor

Jan 18—Stressing the importance of factors other than octane ratings and compression ratios, **T. B. Rendel** gave a most interesting talk on today's engine-fuel problems before this Section.

The importance of maintaining consistent performance, providing durability of engine components and achieving overall economy of operation was brought into sharp focus as being of at least equal significance with the great expenditures of effort currently being made in the field of higher fuel octane ratings and engine compression ratios.

Rendel, assistant manager of the products application department of Shell Oil Co., pointed out inconsistencies of operation with given fuels and compression ratios as a function of combustion chamber deposits and improper spark timing. He stressed the importance of further development in the field of variable spark timing by engine builders, and the need for the petroleum industry to pursue the problems of combustion chamber deposits.

The role of lubricating oil additives as a means of improving engine durability was discussed at some length. The effects of partial combustion products, sulfur-containing fuels and jacket temperatures were analyzed, and it was shown that the use of proper

additives will definitely tend to prolong the life of engine parts.

Discussing economy of operation, Rendel pointed out that driving technique is still one of the most difficult variables to analyze and contend with, despite all efforts of the automotive and petroleum industries to reduce operating costs.

Ways to Improve Steel Strength

• Central Illinois Section
Harlow Piper, Field Editor

Jan. 22—We still have much to learn about utilizing the potential strength of steel, according to **Dr. Oscar Horger**, chief engineer of the railway division of Timken Roller Bearing Co., who spoke on "Improved Strength through Modern Design".

Testing small samples of materials often gives misleading information. Production processes such as burning, turning, coining, and straightening add many stresses to a part that are revealed only when the actual part is tested.

Stresses Can Be Useful

Residual stresses, however, can be incorporated in a beneficial manner. Rolling a surface can raise residual stresses to a depth of seven-eighths of an inch in a shaft. Fillets can be strengthened considerably at a very low cost by rolling. Shot-peening can be used but it is expensive and affects the surface for only a few thousandths of an inch deep.

Dr. Horger showed slides of methods designers can use to avoid stress raisers caused by sharp corners and notches. A part can often be strengthened by removing metal if it directs stress away from abrupt changes in section.

Reports Results On GM Test Engine

• Kansas City Section
R. W. Laing, Field Editor

Feb. 6—A series of tests with the General Motors Research high-compression test engine at varying compression ratios from 6:1 to 12:1 showed that this particular engine could be used to rate fuels of widely different anti-knock quality without resorting to abnormal ignition timings, reported **M. A. Remondino**, technical representative

of the Ethyl Corp. Research Laboratories.

Remondino gave a review, with the use of slides, of the paper "Evaluation of Motor Fuels for High-Compression Engines" by M. M. Roensch and J. C. Hughes of Ethyl. This paper was previously presented at the 1950 SAE National West Coast Meeting in Los Angeles.

A very interesting discussion concerning the relative merits of various automotive engines followed the presentation of this paper.

Stresses Importance Of Strategic Materials

• Milwaukee Section
E. L. Conn, Field Editor

Feb. 2—The present situation with regard to materials is primarily a proposition of carefully surveying our needs rather than expecting to get what we want. **Henry Knowlton**, supervisor of engineering materials for International Harvestor Co., presented a very timely talk on materials and what engineers can do about the situation. He emphasized the extreme importance of such a subject in time of an emergency in that the more that can be done with "material" and "materiel", the less has to be done with men.

Cooperative Effort Needed

While the past experience of World War II will be helpful, it is important to recognize that considerably more will be expected of materials, because of rapid advancement within the various engineering fields, such as jet propulsion, high temperature gun operation, and so forth. To do this and still conserve critical materials, Knowlton stressed, is going to require considerable cooperative effort of government and industry.

Knowlton commented briefly on the location of sources of strategic materials, and then outlined some possible substitute materials.

The remainder of his talk related to usage of steel, especially in the automotive field. To illustrate that even within any given field such as the automotive industry any specific part may be made of a considerable variety of different materials, he used a steering knuckle as an example. Data from 12 companies indicated usage of six different steels; the center hardness ranged from 29 to 49 Rockwell C.

The metallurgist has been able to classify failures of automotive parts as follows:

1. Wear.
2. Permanent deflection.
3. Temporary deflection.
4. Breakage—occurring because of lack of strength in a critical area, lack of toughness, or undesirable internal stress.

Residual stress is a factor of major magnitude in cases of failure and it was on this point that Knowlton elaborated by using several examples. The residual stress is directly affected by the use of alloy and also by the heat-treat procedure. For the metallurgist to be able to contribute on the analysis of residual stresses, it is imperative that data on both the outside and center of the piece be made available.

During discussion of his talk, Knowlton was asked to discuss more fully the "spalling" of gear teeth, and in answer he reported that such failures are difficult to analyze and at least two theories have been developed. The first is incorrect lubrication which leads to failure of the surface because the allowable tensile stress is exceeded. The second theory is that the material

fails in shear below the surface. Also, it may be true that a combination of the two causes a failure, or "spalling".

In answer to a question as to whether or not residual stresses can be located by any method, Knowlton answered that it can be done, but the method is very time consuming. Some work is being done to develop better methods and the use of X-ray diffraction appears to have possibilities.

Gasoline Lab Ratings Don't Tell Whole Story

• Mid-Continent Section
D. W. Frison, Field Editor

Feb. 2—The road antiknock preformance of gasolines cannot always be predicted accurately from their laboratory ratings, according to **M. L. Alspaugh,** Ethyl Corp. research engineer.

"In order to obtain a realistic road rating of a fuel it is necessary to make ratings in a number of makes of vehicles whose antiknock requirements it is intended to satisfy", Alspaugh informed the 70 SAE members and guests.

"The reasons for large variations in road ratings (at least four or more octane numbers) in a given car for fuels of equal Research octane number are not fully understood. The difference in the Motor Method ratings of these fuels do not explain the variations, nor des the TEL content appear to be a factor. In making road antiknock evaluations, the fuel technologist must recognize that changes in atmospheric conditions (such as temperature, humidity, and barometric pressure) as well as differences in car makes and ignition timings can all affect fuel ratings", Alspaugh explained.

"Work with the Borderline Procedure, which is used in research and development work on gasolines, has shown that the Research and Motor octane numbers may be indicative of low and high speed antiknock performance, respectively. Furthermore, fuels which give the best road performance throughout the speed range are generally those which, for a given Research rating, have the highest Motor rating. Highly sensitive fuels, depending on their hydrocarbon composition, may give inferior high-speed antiknock performance even when they have a reasonable motor octane number.

"The use of torque converter type automatic transmissions may or may not change maximum antiknock requirement, depending on the engine", he concluded.

C. A. Hall, Ethyl's assistant research supervisor and co-author of the paper, also was on hand.

Concluding the meeting, Chairman W. K. Randall presented Ray Hilligoss, manager of the Bartlesville Bus Co., with an SAE certificate in appreciation of his efforts as last year's chairman.

Rainmaking Expert Describes Techniques

• Mohawk-Hudson Group
Donald C. Peroutky, Field Editor

Feb. 14—Modern scientific methods of producing rain and snow were discussed at this meeting by **Dr. Bernard Vonnegut** of General Electric Co.'s research laboratory. Basic experiments performed in the laboratory re-

vealed that small particles of dry ice would transform supercooled clouds into snow. Shortly afterward, Vonnegut found that the compound silver iodide would do the same job, because its crystalline structure closely resembles that of ice.

This initial laboratory work was expanded and directed toward weather control by actual meteorological experiments carried out under Project Cirrus—sponsored by the Signal Corps and Office of Naval Research in consultation with the GE Research Laboratory.

Vonnegut showed slides illustrating the construction and operating characteristics of a silver iodide smoke generator. Further slides of aerial photographs showed the snow formation areas in cloud banks seeded with silver iodide from an airplane. It was pointed out that seeding apparatus is relatively simple and inexpensive, and that many private individuals are groups throughout the country are engaged in rainmaking attempts by the cloud seeding process both from the ground and by air.

While success of these attempts is not definitely established, the general results of experiments conducted under Project Cirrus indicate that producing rain by seeding supercooled cloud formations is possible. In fact, the use of silver iodide may have some effect on weather some thousands of miles from the seeding area, as the seeded particles can be carried great distances by atmospheric disturbances.

The discussion was concluded with the showing of an elapsed-time moving picture of cloud formations photographed by Dr. Vincent Schaefer of the research laboratory. The pictures showed the dynamic character of clouds usually unnoticed by those who only occasionally glance skyward.

Small Industrial Diesels Discussed

• Chicago Section
Peter P. Polko

Feb. 13—The untiring efforts of International Harvester Co.'s Divisional Chief Engineer Merrill R. Bennett, meeting chairman, brought an excellent turnout to this meeting despite inclement weather. The great interest in the paper scheduled for the technical session was evidenced by the gathering of 400 members and guests. Among the many dignitaries who honored the Section by their presence were C. E. Frudden and S. W. Sparrow, both past-presidents of SAE.

A. W. Pope, chief research engineer of Waukesha Motor Co., was principal speaker of the evening. Pope's 30 years of engineering activity qualified him well for the discussion of "Small Industrial Diesel Engines."

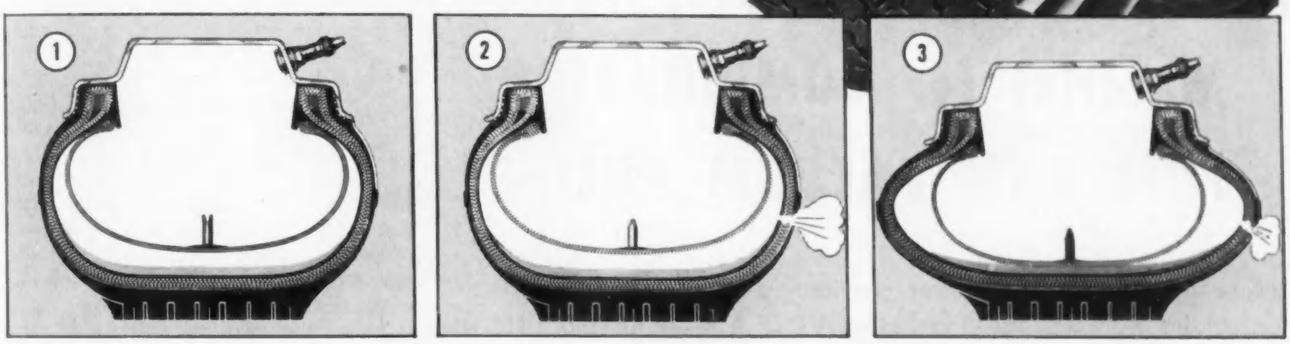
Predicting an excellent future for small diesels, the speaker said "The diesel cycle is the most efficient known method of converting liquid fuel heat energy to usable power in small units, and it will therefore come into general use wherever the fuel cost is an important part of the operating expense."

There are several reasons why the small diesel engine has not yet come into general use on the American market. One factor is hard starting. This has been particularly troublesome with divided turbulent combustion chamber engines of the Waukesha Ricardo Comet type. But a recent

Firestone ANNOUNCES

THE WORLD'S FIRST BLOWOUT-SAFE, PUNCTURE-PROOF TUBELESS TIRE

Here is a tire so completely safe that it marks the beginning of a new era in highway safety. Firestone is cooperating with the Government in conserving critical materials, so production of this new tire is limited for the time being.



Pictured above are cross-sections of the world's first blowout-safe, puncture-proof, tubeless tire. Figure 1—shows the tire under normal inflation; Figure 2—shows what happens to outer tire in case of blowout; Figure 3—shows how a large volume of the air is retained in the inner diaphragm, giving the tire sufficient support to make the car easily controllable at all speeds.

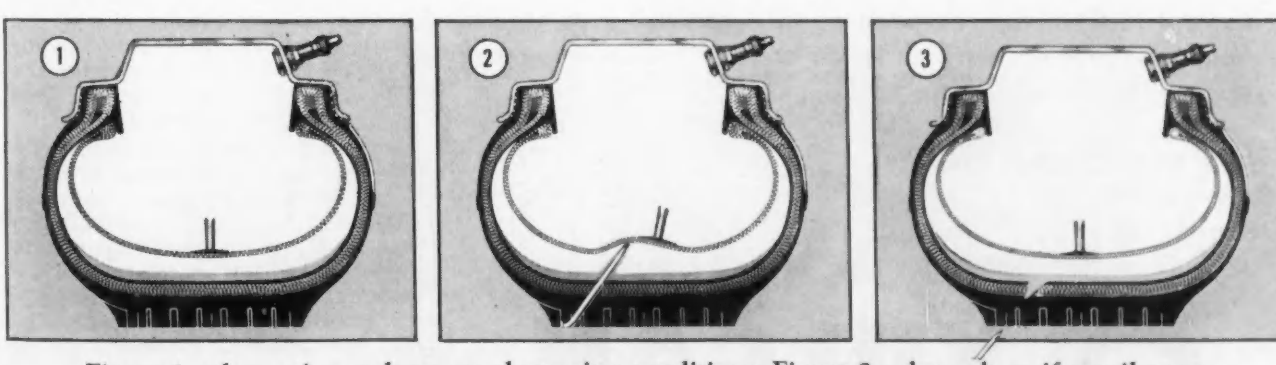


Figure 1—shows tire under normal running conditions; Figure 2—shows how if a nail penetrates the tread, the inner diaphragm is pushed aside and soft, pliable rubber within the tire surrounds the cause of the puncture, preventing loss of air. Figure 3—when the cause of the puncture is removed, this soft rubber seals the hole so that no repairs are necessary.

development in injector design by Ricardo and C.A.V. in England has made the comet type combustion chamber as easy-starting as an open chamber engine. The new injector is a standard pintle type nozzle with a small auxiliary spray hole drilled at an angle into the side of the pintle passage. This arrangement provides an auxiliary spray directed toward the throat of the comet combustion chamber. Apparently the temperature of the air at the entrance to the comet swirl chamber does not fall much below its peak compression temperature, and fuel directed toward this point, therefore, ignites readily. The location of the auxiliary spray hole is such that at low speeds most of the fuel issues from the auxiliary hole. At high speeds most of the fuel issues from the main pintle passage.

Many diesel operators solve the extreme cold starting problem through use of di-ethyl ether priming.

Another factor retarding the acceptance of the small diesel engine has been its characteristically rough and noisy operation, especially at light load. The Waukesha engineers believe the diesel light load rattle problem is close to a solution. There is still much unknown about proper control of injection characteristics necessary to obtain smooth efficient combustion.

Although undesirable characteristics such as hard starting and rough running have retarded widespread popularity of small diesels, the most important deterrent has been high cost.

Small Diesels Popular Abroad

Foreign markets long ago accepted small diesels because the market price of diesel fuels was so high that the improved diesel efficiency gave a fuel cost saving which easily offset the high first cost of the engine and any mechanical inconveniences. Experience in foreign markets has clearly defined the basic problem of developing an American market for small diesel engines. It is to build the small diesel at a cost closer to the cost of a carburetor type engine.

The basic cost of an engine framework suitable for diesel pressures used to be very much greater than a carburetor engine of the same size. But, due to the improvement in the antiknock quality of carburetor engine fuels, it has been necessary to increase the compression ratio to such an extent that a carburetor engine structure which is suitable for the higher octane gasolines is now equally suitable for diesel operation. The basic engine structure today, therefore, costs the same whether it be a modern carburetor engine or a diesel.

Equalizing the basic engine cost of a diesel and carburetor engine structure is not the whole solution to the problem. In small diesels the conventional injection equipment required may have a cost greater than the total cost of the basic engine. To meet this challenge, the Waukesha Motor Co. has successfully developed a low-cost long-life single-plunger injection pump.

After Pope's presentation of his paper, pertinent comments were added in discussions given by **C. N. Guerasimoff** of Buda Co., **M. L. Fast** of Cummins Engine Co., and **O. D. Treiber** of Hercules Motors Corp.

Students Enter Industry

Continued from Page 76

RUSSELL A. SNOOK (California State Polytechnic College '50) to Nylander and Sorenson Farm Equipment Dealers, Dos Palos, Calif.

J. W. PRISER (Parks College '50) to Glenn L. Martin Co., Baltimore, Md.

STANLEY EDWARD SHAVEL (University of Colorado '49) to Thatcher Furnace Co., Garwood, N. J.

RAYMOND E. SICKLER (University of California '50) to Westinghouse Electric Corp., Sunnyvale, Calif.

MICHAEL J. McINERNEY (Michigan State College '50) to Aeroproducts Division, GMC, Dayton, Ohio.

VICTOR THOMAS LESHOCK (The Pennsylvania State College '50) to The Kellex Corp., New York City.

ROMAN E. KOZINSKI (Lawrence Institute of Technology '50) to Fleetwood Plant Division of GMC's Fisher Body Division, Detroit.

EDWARD A. HUMPHRY (University of Massachusetts '50) to State Department of Public Works, Worcester, Mass.

GORDON JAMES ANGERMAN (Loyola University '50) to Lockheed Aircraft Corp., Burbank, Calif.

ROBERT LEON LOGELIN (Illinois Institute of Technology '50) to Sinclair Refining Co., Harvey, Ill.

PETER STABOVITZ, JR., (Indiana Technical College '50) to Bahan Textile Machinery Co., Greenville, S. C.

STEVE B. SAROS (Indiana Technical College '50) to American Steel Dredge Co., Fort Wayne, Ind.

CHESTER F. TYMINSKI (Rensselaer Polytechnic Institute '50) to Hazelett Strip Casting Process, Greenwich, Conn.

GEORGE W. BATH (Northrop Aeronautical Institute '50) to A. V. Roe, Canada, Ltd., Ontario.

GLEN A. WEINERT (University of Michigan '50) to Ohio University, Athens, Ohio.

FRED L. MAIN (Fenn College '50) to Euclid Road Machinery Co., Cleveland.

ARTHUR F. LEWIS (University of Detroit '50) to Hyde & Bobbio, Detroit.

JOHN F. LEAMON (Purdue University '50) to Westinghouse Electric Corp., Kansas City, Mo.

JOHN C. BLAKE (Purdue University '50) to Sperry Gyroscope Co., Great Neck, N. Y.

JAMES DONALD BONNEVILLE (Michigan College of Mining and Technology '50) to Fairbanks, Morse & Co., Beloit, Wis.

KENNETH C. BOWMAN (Bradley University '50) to International Business Machines Corp., Chicago.

L. B. EVANS (University of British Columbia '50) to A. V. Roe Canada, Ltd., Ontario.

HOWARD E. DAHL (Illinois Institute of Technology '50) to Carr & Wright, Inc., Chicago.

Continued on Page 100


Proper Preparation of cylinder wall...
Black dots show how the graphitic content of RAMCO CAST-IRON OIL RING is transferred from ring to cylinder walls to prepare surface
SPIRO-SEAL requires NO INNER-RING CONTACT during initial period
Illustrating the utilization of cast-iron bearing surfaces in a ring designed for replacement purposes.
of interest to engineers
Memo
From: M. W. MARIEN, Chief Engineer
SUBJECT: Consideration of the wear factor in Piston Ring Design
Curbing wear of cylinder walls has always been a major concern of piston ring designers. Here at Ramsey it is a factor that is never lost sight of by the Engineering Group.
One of the major principles employed by Ramsey in the interest of curbing cylinder-wall wear is the utilization of cast-iron contact surfaces. It is well-known to automotive engineers that the soft, graphitic content of cast-iron acts as a lubricant when it contacts a harder surface.
Ramsey Ring Design puts the cast-iron principle to work to insure proper preparation of the cylinder walls. Stabilization, rather than wall pressure to control oil and blow-by, is one of the reasons why it is possible for Ramsey to utilize this principle. Another is that, even though steel is used, it is employed as a secondary bearing surface, instead of a primary one.
We have found that the proper preparation of cylinder walls is one of the essentials to longer ring life and maximum curbing of the wear factor.
We welcome your inquiry regarding this and additional wear-curbing principles employed by the Ramsey Piston Ring Design, and how this design may be of use to you for original equipment, replacement or other purposes.
RAMSEY CORPORATION
General Offices, St. Louis, Missouri

Students Enter Industry

Continued from Page 98

JAMES LLOYD HARVEY (Colorado University '50) to Allis-Chalmers Mfg. Co., West Allis, Wis.

THOMAS M. HAMILTON (Cal-Aero Technical Institute '50) to Wm. R. Whittaker Co., Los Angeles.

JESS LINDEN BRINEGAR, JR., (Purdue University '50) to Webster Mfg. Inc., Tiffin, Ohio.

R. F. GILMORE (Northrop Aeronautical Institute '50) to Chance Vought Aircraft, Division of United Aircraft Corp.

JACK E. GREGG (Michigan State College '50) to General Motors Proving Ground, Milford, Mich.

LELAND D. CHAMNESS (Northrop Aeronautical Institute '50) to Aircraft Engineering & Maintenance Co., Oakland, Calif.

ORVILLE LEONARD MUSCLOW (Indiana Technical College '50) to Eastman Kodak Co., Rochester, N. Y.

WILLIAM E. TEMPLE (University of Colorado '50) to Douglas Jardine, Colorado Springs, Colo.

RICHARD A. LAUBENSTEIN (University of Wisconsin '50) to North American Aviation, Inc., Downey, Calif.

GEORGE FABIAN (Northrop Aeronautical Institute '50) to Hughes Aircraft Co., Culver City, Calif.

WILLIAM P. D. WILSON, JR., (University of Wichita '50) to Boeing Airplane Co., Seattle, Wash.

J. F. SMALLWOOD (Indiana Technical College '50) to The National Cash Register Co., Dayton, Ohio.

LESLIE J. JOHNSTON (Northrop Aeronautical Institute '50) to Douglas Aircraft Co., Santa Monica, Calif.

JOHN S. TROGNER (Chrysler Corp. '51) to Gulf Refining Co., Detroit.

STANLEY V. LEMMON (Purdue University '50) to Allison Division, GMC, Indianapolis, Ind.

HARRY F. KRAMP (California State Polytechnic College '50) to Eighth Air Depot, Sebring, Fla.

GEORGE J. WAGNER (University of Wisconsin '50) to Central Foundry Division, GMC, Defiance, Ohio.

PAUL F. TAESLER (San Diego State College '50) to Solar Aircraft Co., San Diego, Calif.

GARY G. SINTON (Aeronautical University '50) to Glenn L. Martin Co., Baltimore, Md.

ALFRED SIDEL (University of Massachusetts '50) to Allis Chalmers Mfg. Co., Boston, Mass.

ANGELO A. ROSSELLI (Villanova College '50) to Westinghouse Electric Corp., Lester, Pa.

DON C. ROGERS (University of Illinois '50) to Scully-Jones & Co., Chicago.

WESLEY O. REED (Oregon State College '50) to Guy Atkinson Co. & J. A. Jones Construction Co., North Richland, Wash.

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Students Enter Industry

Continued from Page 100

WILSON DALE COOPER (Municipal University of Wichita '50) to Lincoln-Mercury Division, Ford Motor Co., Kansas City, Mo.

ALEXANDER FULTON (University of British Columbia '50) to Dept. of Public Works, Province of British Columbia.

DANIEL T. COTTONE (The Pennsylvania State College '51) to Curtiss-Wright Corp., Caldwell, N. J.

GEORGE R. ELGES (General Motors Institute '50) to Cadillac Cleveland Tank Plant, Cleveland, Ohio.

BERNARD M. VENESKY (Indiana Technical College '50) to Navy Bureau of Aeronautics, Washington, D. C.

BERTRAND L. GULICK III (Academy of Aeronautics '50) to Thermoid Co., Trenton, N. J.

New Engine Standards

Continued from Page 79

diameter groups: 16 to 19 in., 20 to 24 in., 25 to 28 in., and 29 to 36 in. The Engine Committee has asked the subcommittee that did the job to expand the Practice to include larger size fans.

Use of standard rather than special size thermostats is the aim of the thermostat pocket Standard. Thermostat makers would like the engine man to design a pocket that will accept a standard unit, rather than to come up with a pocket that calls for a special size. There are too many variations in the size of the cylinder-head water outlet opening and shape of inlet opening in the water outlet elbow, notes the SAE Thermostat Pocket Subcommittee, headed by H. B. Drapeau, Dole Valve Co.

3 Pocket Sizes Named

The new Standard specifies two sizes in the choke-type pocket and one size in the bypass-type thermostat pocket.

The cluster-type thermostat pocket (using two or more standard thermostat units) is said to be acceptable in the new Standard. But the group will study the possibility of larger size pockets to eliminate, if possible, the cluster arrangement. Manufacturers of trucks and large engines would prefer to use one large thermostat instead of several smaller ones.

It's bad practice to install the thermostat in the water outlet elbow with retaining rings or springs, advises the new Standard. This method can bring excessive leakage around the thermostat, especially if damaged or disintegrated retainers are not replaced.

The airflow or vacuum governor flange Standard is offered to automotive engineers as a guide for future design. It includes sizes in production and those that have field acceptance. The Standard also defines 10 commonly used governor terms to bring about language uniformity in this area.

New Designations Suggested

The revised Standard on automotive carburetor flanges has been brought into line with current practice. To avoid confusion, the Standard recommends designating carburetor size by both SAE throttle flange size and actual throttle bore diameter. For example, 1¼ - 1 7/16 would represent a 1¼ SAE flange and a 1 7/16 actual throttle bore.

Continued on Page 104


White 3000
Positive Ignition and Engine Control in One Package
WHITE MOTOR MODEL 3026 tractors use the Holley Pressure Distributor-Governor combination as standard equipment. This patented design combines vacuum actuated spark control with precision engine-speed control, when used in conjunction with the Holley governor type carburetor.
FOR HALF A CENTURY, ORIGINAL EQUIPMENT MANUFACTURERS FOR THE AUTOMOTIVE INDUSTRY.
HOLLEY
Carburetor Co.
DETROIT 6, MICHIGAN

Continued from Page 102

Standard Cable, Connector To End Truck-Trailer Woes

THE new SAE Recommended Practice for seven-conductor cable together with a standard electrical connector (developed by the American Trucking Associations) should remedy a long-standing fleet problem. Lack of a standard connector and cable between truck tractors and trailers has been the bane of fleet men.

Many fleet operations require that full and semi-trailers be switched from one tractor to another, even on one run. Quite often the tractor plug doesn't fit the trailer receptacle. That's because there has been no standard connector.

The SAE recommended practice for truck trailer connectors, sets up dimensional specifications that will provide this much-needed interchangeability. It conforms with a similar equipment specification developed by the American Trucking Associations.

The companion recommended practice, for the seven-conductor jacketed cable, was developed by the SAE Electrical Equipment Committee at the request of ATA. A minimum of six conductors are needed. But a seven conductor cable is easier to manufacture and the seventh conductor is available for auxiliary circuits.

A third Electrical Equipment committee project recently completed is a recommended practice for radio noise suppressors. It specifies performance tests for suppressors in center tower of distributors, in leads, and on spark plugs.

The SAE Spark Plug Standard also has been revised. Dimensional data have been modified and the spark-plug spade-type cable terminal, now obsolete, has been eliminated.

SAE Spark Arrester Test Held Fire Prevention Aid

THE new SAE Standard for Spark Arresters will help diminish the fire hazard from internal combustion engines powering vehicles working in wooded areas. Arresters complying with this test code should minimize exhaust sparks and hot carbon par-

ticles emitted by earthmoving and farm machinery.

The potential fire danger from diesel and gasoline and diesel engine exhaust gases in certain places has long been a concern of equipment operators, manufacturers, and local regulating bodies. During dry periods in particular, glowing exhaust sparks have been known to generate destructive fires in forests and grain fields.

One way to ease the problem is to nip the cause in the bud with a spark-trapping device in the exhaust system. But until now there has been no way of measuring the effectiveness of such a spark arrester.

Some four years ago the SAE Spark and Flame Arrester Committee undertook the job of developing spark arrester specifications. Product of its labors is a uniform procedure for testing spark arresters.

The test procedure consists of injecting carbon particles into the exhaust system. The engine, with arrester attached, is run through a specified test cycle. Carbon particles leaving the exhaust are trapped and screened. To pass the test, the arrester must trap at least 90% of small carbon particles injected (those passing through a 14-mesh Tyler screen and retained on a 28-mesh screen).

The U. S. Department of Agriculture's Forest Service has been deeply interested in this work. It says such a test code is urgently needed to enforce federal regulations and local fire laws. Indications are that the SAE Spark Arrester Standard will be adopted by the Forest Service in its fire control regulations.

The Standard was developed by a committee chairmanned by W. W. Lowther, Donaldson Co., Inc. Other committee members are: R. C. Williams, Caterpillar Tractor Co.; D. L. Davis, Jr., Studebaker Corp.; E. P. Gohn, Atlantic Refining Co.; L. E. Overholt, International Harvester Co., and C. G. A. Rosen, Caterpillar Tractor Co.

Approved and Proposed Aero Material Specs

ONE new and 17 revised SAE Aeronautical Material Specifications were approved recently by the SAE Technical Board. Eighty others—four new and 76 revised—are being circulated to industry for comment and criticism by the SAE Aeronautical Material Specifications Division.

a. The new Specification approved is:

- AMS 3071, Concentrate, Corrosion Preventive Compound, Aircraft Engines

b. The revised ones approved are:

- AMS 3072B, Compound, Corrosion Preventive, Aircraft Engine
- AMS 5010C, Steel, Screw Stock (SAE 1112)
- AMS 5022E, Steel, Free Cutting (0.14–0.20C) (SAE 1117)
- AMS 5030A, Steel Wire, Welding, Low Carbon
- AMS 5036B, Steel Sheet and Strip, Aluminum Coated, Low Carbon
- AMS 5050D, Steel Tubing, Seamless, 0.08–0.13C (SAE 1010) Annealed
- AMS 5061A, Steel, Low Carbon
- AMS 5062A, Steel, Low Carbon
- AMS 5075A, Steel Tubing, Seamless (0.22–0.28C) (SAE 1025)
- AMS 5110A, Music Wire, Commercial

Continued on Page 108

WHO makes HYPOID GEARING makes a difference!

TIMKEN-DETROIT

Is The One Truck Axle Manufacturer With Years of Hypoid Experience and Know-How!

The Timken-Detroit Axle Company was the first manufacturer of heavy-duty truck axles to realize that the inherent greater torque capacity of hypoid gears is advantageous in heavy-duty rear axles. In 1944, after several years of development work, the first rear axle for heavy-duty motor trucks equipped with hypoid gears was placed in production. Since that time, millions of ton miles of testing under all conditions in actual service, plus exhaustive laboratory testing, has *proved* the cost-saving ruggedness and durability of Hypoid Gearing.

Early in 1947, The Timken-Detroit Axle Company placed in regular production a complete series of Hypoid-equipped "3 for 1" rear axles for trucks of 15,000 to 28,000 G. V. W., with engines developing from 100 to 300 horsepower. In this series of "3 for 1" axles, hypoid gears are used for single-reduction final drives, and for the first gear reduction in single-speed and two-speed double-reduction final drives.

Today, Timken-Detroit offers a complete range of capacities—a hypoid rear axle for each size of pneumatic tires—with the correct type of final drive and gear ratio for the job to be done.

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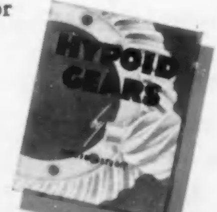

TIMKEN Detroit AXLES

A PRODUCT OF THE TIMKEN-DETROIT AXLE COMPANY
DETROIT 32, MICHIGAN

Accepted Standard
TRADE MARK REGISTERED

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Approved and Proposed Aero Material Specs

Continued

• AMS 5132C, Steel, High Carbon

• AMS 6260E, Steel, 3.25Ni—1.2Cr—0.1Mo (0.07–0.13C) (SAE 9310)

• AMS 6263C, Steel, 3.25Ni—1.2Cr—0.1Mo (0.11–0.17C) (SAE 9315)

• AMS 6264C, Steel, 3.25Ni—1.2Cr—0.1Mo (0.14–0.20C) (SAE 9317)

• AMS 6266A, Steel, 1.85Ni—0.5Cr—0.25Mo—0.05V—0.004B

• AMS 6342B, Steel Bars and Forgings, 1Ni—0.8Cr—0.25Mo (0.38–0.43C) (SAE 9840)

• AMS 7225B, Rivets, Steel

c. The new proposed Specifications now being circulated to industry for comment and criticism are:

• AMS 3116, Compound, Airfoil Smoothing, Hard

• AMS 4352, Magnesium Alloy Extrusions, ZK60A—T5

• AMS 7440, Ball, Steel—Hardened

• AMS 7445, Ball, Corrosion Resistant Steel—17 Chromium

d. The proposed revised Specifications being circulated to industry for comment and criticism are:

• AMS 2402D, Zinc Plating

• AMS 2403A, Nickel Plating

• AMS 2406B, Chromium, Plating, Hard

• AMS 2408A, Tin Plating

• AMS 2409A, Tin Plating, Immersion

• AMS 2410A, Silver Plating, Nickel Strike—High Bake

• AMS 2412A, Silver Plating, Copper Strike—Low Bake

• AMS 2414A, Lead Plating

• AMS 2415B, Lead and Indium Plating

• AMS 2418A, Copper Plating

• AMS 3270A, Synthetic Rubber Sheet, Cotton Fabric Reinforced, Weather Resistant Chloroprene Type

• AMS 4021, Aluminum Alloy Sheet, Aluminum Alloy Clad Magnesium Silicon Copper (ALC 61S-O)

• AMS 4022, Aluminum Alloy Sheet, Aluminum Alloy Clad Magnesium Silicon Copper (ALC 61S-T4)

• AMS 4023, Aluminum Alloy Sheet, Aluminum Alloy Clad Magnesium Silicon Copper (ALC 61S-T6)

• AMS 4530B, Copper-Beryllium Alloy Sheet and Strip, 98Cu—2Be Solution Treated

• AMS 4532A, Copper-Beryllium Alloy Sheet and Strip, 98Cu—2Be Solution Treated, Half Hard

• AMS 4610E, Brass, Free Cutting, 61.5Cu—35.5Zn—3Pb, Half Hard

• AMS 4612C, Brass, Naval, 60.5Cu—0.8Sn—38.7Zn, Hard

Approved and Proposed Aero Material Specs

Continued

- AMS 4625D, Phosphor Bronze, 95Cu—5Sn, Hard
- AMS 4630D, Aluminum Bronze, 90Cu—8.5Al, Soft
- AMS 4650D, Copper-Beryllium Alloy, 98Cu—2Be, Solution Treated
- AMS 4720B, Phosphor Bronze Wire, 95Cu—5Sn, Spring
- AMS 4725A, Copper-Beryllium Alloy Wire, 98Cu—2Be, Solution Treated
- AMS 4803A, Zinc Alloy Castings, Die, 4Al—0.04Mg, As Cast
- AMS 5502A, Steel Sheet and Strip, Low Heat Resistant, 5Cr—0.5Mo
- AMS 5510E, Steel Sheet and Strip, Corrosion and Heat Resistant 18Cr—10Ni—Ti (SAE 30321)
- AMS 5511A, Steel, Sheet and Strip, Corrosion and Heat Resistant 18Cr—8Ni, Extra Low Carbon
- AMS 5514A, Steel Sheet and Strip, Corrosion Resistant, 18Cr—11Ni (Deep Drawing and Spinning)
- AMS 5515C, Steel Sheet and Strip, Corrosion Resistant, 18Cr—9Ni (Deep and Shallow Forming)
- AMS 5516C, Steel Sheet and Strip, Corrosion Resistant, 18Cr—9Ni, Cold Rolled
- AMS 5517D, Steel Sheet and Strip, Corrosion Resistant, 18Cr—8Ni (Cold Rolled—125,000 psi)
- AMS 5518C, Steel Sheet and Strip, Corrosion Resistant, 18Cr—8Ni (Cold Rolled—150,000 psi)
- AMS 5519E, Steel Sheet and Strip, Corrosion Resistant, 18Cr—8Ni (SAE 30302) Cold Rolled—185,000 psi
- AMS 5522B, Steel Sheet and Strip, Corrosion and Heat Resistant, 25Cr—20Ni—2Si
- AMS 5524A, Steel Sheet and Strip, Corrosion and Heat Resistant, 18Cr—13Ni—2.5Mo
- AMS 5530B, Alloy Sheet, Corrosion and Heat Resistant, Nickel Base 17Mo—16.5Cr—6Fe—5W
- AMS 5542C, Alloy Sheet, Corrosion and Heat Resistant, Nickel Base 15Cr—7Fe—2.5Ti—1(Cb+Ta)—0.7Al
- AMS 5560C, Steel Tubing, Seamless, Corrosion Resistant, 18Cr—9Ni
- AMS 5565C, Steel Tubing, Welding, Corrosion Resistant, 19Cr—9Ni
- AMS 5566B, Steel Tubing, Corrosion Resistant, High Pressure Hydraulic 18Cr—8Ni
- AMS 5572A, Steel Tubing, Seamless, Corrosion and Heat Resistant, 25Cr—20Ni (SAE 30310)
- AMS 5580C, Alloy Tubing, Seamless,

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Approved and Proposed Aero Material Specs

Continued

Corrosion and Heat Resistant, Nickel Base 15.5Cr—8Fe, Annealed.

- AMS 5667C, Alloy, Corrosion and Heat Resistant, Nickel Base 15Cr — 7Fe — 2.5Ti—1(Cb + Ta)—0.7Al
- AMS 5668C, Alloy, Corrosion and Heat Resistant, Nickel Base 15Cr — 7Fe — 2.5Ti—1(Cb + Ta)—0.7Al
- AMS 5681A, Welding Electrodes, Coated, Corrosion and Heat Resistant Steel 19Cr—9Ni—Cb
- AMS 5683B, Alloy Wire, Corrosion and Heat Resistant, Nickel Base 15.5Cr —8Fe—Cold Drawn
- AMS 5684A, Welding Electrodes, Coated, Alloy, Corrosion and Heat Resistant Nickel Base—16Cr—9Fe
- AMS 5685C, Steel Wire, Corrosion Resistant, 18Cr—8Ni, Solution He Treated
- AMS 5686A, Steel Wire, Corrosio Resistant, 18Cr—10Ni, Solution He Treated
- AMS 5688C, Steel Wire, Corrosio Resistant, 18Cr—8Ni, Spring Tempe
- AMS 5691A, Welding Electrodes Coated, Steel, Corrosion and Heat Resistant 18Cr—13Ni—2Mo
- AMS 5694A, Steel Wire, Corrosion and Heat Resistant, 25Cr—20Ni
- AMS 5695A, Welding Electrodes, Coated, Steel, Corrosion and Heat Resistant 25Cr—20Ni
- AMS 5710B, Steel, Valve—20Cr—2.3Si—1.3Ni (0.76—0.86C)
- AMS 5725A, Steel, Corrosion and Heat Resistant, 16Cr—25Ni—6Mo
- AMS 5727A, Steel, Corrosion and Heat Resistant, 16Cr—25Ni—6Mo
- AMS 5730A, Steel, Corrosion and Heat Resistant, 19Cr—12Ni—3.2W 1Cb —0.15N
- AMS 5725A, Alloy, Corrosion and Heat Resistant, Nickel Base—28Mo—5Fe—0.35V
- AMS 5760A, Alloy, Corrosion and Heat Resistant, 37Ni—20Co—18Cr—3Mo—2.9Ti
- AMS 5782A, Steel Wire, Corrosion and Heat Resistant, 19Cr—9Ni—1.5W —1Cb—0.5Mo—0.2Ti
- AMS 5783A, Welding Electrodes, Coated, Steel, Corrosion and Heat Resistant 19Cr—9Ni—1.5W—1Cb—.5Mo
- AMS 5785A, Welding Electrodes, Coated, Steel, Corrosion and Heat Resistant 29Cr—9Ni.
- AMS 5794A, Alloy Wire, Corrosion and Heat Resistant, Iron Base 20Cr—20Ni—20Co—3Mo—2W—1Cb
- AMS 5795A, Welding Electrodes, Coated, Alloy, Corrosion and Heat Resistant Iron Base—20Cr—20Ni—20Co —3Mo—2W—1Cb
- AMS 6450B, Steel Spring Wire, 0.95Cr —0.15V (0.48–0.53C) (SAE 6150)
- AMS 7240A, Washers, Spring Lock
- AMS 7247A, Inserts, Thread Form, Phosphor Bronze, 95Cu—5Sn
- AMS 7301B, Steel Springs, Highly Stressed, 0.95 Cr — 0.2V (0.48–0.53C) (SAE 6150)
- AMS 7304A, Steel Springs, 0.85–1.05C
- AMS 7310B, Piston Rings, Cast Iron
- AMS 7311A, Piston Rings, Centrifugally Cast Iron, 0.5Mo—0.5Cu
- AMS 7320A, Sealing Rings, Cast Leaded Bronze, 80Cu—15.5Sn—4.5Pb
- AMS 7322A, Sealing Rings, Cast Bronze, 81Cu—19Sn
- AMS 7452C, Bolts and Screws, Steel, Alloy—Heat Treated—Roll Threaded
- AMS 7456B, Studs, Steel, Alloy—Heat Treated—Roll Threaded

Copies of the proposed Specifications are available for review from the SAE Aeronautical Department.

New Members Qualified

These applicants qualified for admission to the Society between Jan. 10, 1951 and Feb. 10, 1951. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Baltimore Section

Russell G. Hutter (J), Harold B. Isennock (A), Henry C. Jones (M), Ludwig L. Motulsky (J).

British Columbia

Frank Edward Ashdown (A), James Wm. Daly (A).

Canadian Section

William Close (M), James William Fraser (M), Edward William Fryday (J), Sidney L. Kent (J), Carl E. Lindros (M), G. Gordon McAllister (A).

Central Illinois Section

Gordon C. Gregory (A), Edwin Eugene Hanson (J), Roland Franklin Hughes (J), Rudolph Lenich (J), Ernest Reginald Maxfield (J), Edred B. Williams (J).

Chicago Section

Richard C. Aylward (A), James G. Billmeyer (J), Bruce Wexton Carkin (A), Melvin Joseph Crompton (J), William Webb Fickling, Jr. (J), James A. Guske (J), Jack Charles Hedge (J), Robert Hachtel Kerruish J), Raymond Lampsa (M), Joseph M. Malejki (J), John S. Marshall, Jr. (J), Leo L. Novak (J), Edward Walter Policht (J), Robert L. Pontious (J), Donald L. Powell (J), Philip R. Proctor (M), Zenon J. Raczkowski (J), Thomas D. Sedwick (M), F. Phillip Steiner (M), H. H. Urbach (M), Edward Richard Winkless (J).

Cincinnati Section

Gerald J. Bushman (A), James O. Chaskel (A), Ray M. Gordon (A), Peter Kulka (J), Raymond Francis Welsch (J).

Cleveland Section

John H. Crankshaw (M), Daniel C. Garber (J), Francis U. Hill, Jr. (J), James A. Kloth (J), Earl H. Lenz (M), John R. Lowe, Jr. (J), Elmer J. Scheutzow (J), Ralph C. Soden (A), Arthur G. Wahrenberger (J).

Colorado Group

Beryl R. Bryant (J), Kenneth D. Roberts (J).

Dayton Section

B. F. Alford, Jr. (SM), Eugene Leonard Brickman (J), Dwight Richard Craig (J), Lt. Chester E. McCollough, Jr. (J), Robert A. Minch (J), W. H. Rowley (M), Sterling Brookbank Smeltzer (M).

Detroit Section

Laurence W. Anderson (J), Jirair Andonian (J), Alexander R. Andre (J), Glenn Merritt Berggren (J), Robert H. Clift (J), W. Dean Croom (J), Robert H. Eaton (M), John Festian (M), Robert Warren Fogerty, Jr. (J), Donald A. Forman (J), J. R. Forrester, Jr. (M), Victor Francis (J), William A. Gelgota (J), William A. Hambley (M), John B. Harrison (M), Harland W. Hartmann (J), Donald L. Johnson (M), James Robert Kelly (J), John Stanton Kerrigan (J), Ray L. Kuzma (J), Leon F. LaRocque (J), Norman Levine (J), Henry J. Malik, Jr. (J), Jess Marosi (M), Robert Arthur Meade (A), Clyde A. Morgan (M), Robert Brooks Newill (J), John B. Nicolls, Jr. (M), Anthony J. Payne (M), Charles Louis Payor (M), Edward Francis Petrelewicz (J), Gordon A. Price (J), Eldon L. Regal

Continued on Page 112

New Members Qualified

Continued

(J), Richard Reiter (M), George Rupinski (J), Richard Schneidewind (M), Donald Jack Schwendner (J), Donald B. Smith (M), David E. Stojan (J), Gordon Reed Stone (M), Floyd Sutherland (A), Raymond Taylor (J), Frederick L. Young (J), Robert Lionel Yung (J), John F. Zimmerly (J),

Hawaii Section

Ray G. Medley (A), Harry S. Mizuta (A).

Indiana Section

Clare A. Aldrich (M), George V. Bianchini (J), Edward Gayle Bulpitt (J), Joseph L. Butler (J), Xerrex Y. Cox (A), George Andrew Goepfert (M), Rowland M. Hussey, Jr. (J), Hubert B. Irwin (J), L. A. Rice (M), Wilbur M. Seipel (J), Robert F. Waddell (J).

Metropolitan Section

Herbert Aronson (J), Manfred H. Barth (M), Robert P. Bauman, Jr. (J), Arthur A. Bluj (J), Emil E. Dubs (M), William James Groth (A), Walter L. Hermes (J), James W. Howden (M), Ray Impellittiere (A), Thomas Charles Kaut (J), Carlos D. Kelly (A), James B. Lawson (J), Warren F. Menicke (J), Frank Occhipinti (J), Stanley S. Orkin (J), Herbert R. Otto, Jr. (M), Edward A. Sammis (M), Richard John Scanlan, Jr. (J), David B. Spielman (A), Walter E. Thielhart (J), John C. Zimmer (M).

Mid-Continent Section

Joseph A. Grimmer (J), David R. Vondy (J), Sylvanus C. Walker (J).

Mid-Michigan Section

John Hersh Henning (J), Frank R. Nethaway (M), Charles Marvin Peterson (J).

Milwaukee Section

Roland W. Gitzlaff (M), Granville D. Guttersen (J), Robert A. Harmon (J), Eugene H. Haupt (M), John E. Heuser (M), Donald E. Kiefert (J), George P. Knudsen (M), Walter H. Losse (M), Burnley Mahr (M), Williams B. Milbrath (J), Robert Underwood Sautter (J), Carl E. Schou (M), Theodore J. Schweitzer (M), Harry J. Seaman (M), Howard Floyd Traeder (J), Harold E. Vickerman (J), John Weiland, Jr. (M), John A. Ziebell (J).

Montreal Section

Francis William Chaplin (A).

New England Section

William O. Faxon (M), Robert Gilman (M), Robert Leo Mayer (J).

Continued on Page 114

New Members Qualified

Continued

Northern California Section

Daniel O. Klute (M), Albert F. Labrucherie (M), Hardy G. Reynolds (A), John K. Smyth (M).

Northwest Section

Donald F. Branstrom (J), Nevin Harvey Cope (J), Garrett Duane Shaw (J).

Oregon Section

Remey M. Cox, Jr. (J), Lester Earl Kassebaum (A).

Philadelphia Section

Edwin R. Berg (J), Edward Peter Skralskis (M), James G. Slater (A), Harry Sternfeld, Jr. (J).

Pittsburgh Section

William Harold Chapman (J), Russell M. Franks (M), Timothy W. Merrill (M), Robert Donald Oldfield, Jr. (J), James Girvin Peters (A), Ralph W. Van Sant, Jr. (M).

St. Louis Section

Arthur B. Cook (J), Louis Edwin Durkee (J), Harvey D. Ferris (J), Robert William Travis (J).

San Diego Section

Frank J. Filippi (J), Henry K. Hauser (J), Robert A. Jackson, Jr. (M), John W. Kuczwara (J), Clarence O. Moe (M), Myron Ernest Morrison, Jr. (J), Alvin L. Ohlin (M), John W. Runcel (J), Milburn Richard Smith (J).

Southern California Section

Francis Marsh Baldwin, Jr. (J), Edward J. Bigelow (M), M. L. Bud Cohn (A), Capt. Burdon Louis Davidson (A), Arville R. Ousdahl (M), George Piness, Jr. (J), Walter G. Prevost (J), Clarence T. Rasmussen (M), Lt. (jg) Harold William Reese (J), Clarence E. Siemonsma (A), Allen L. Simms (A), Leonard Michael Sklar (J).

Southern New England Section

Richard L. Catlin (J), Lt. Comdr. Cornelius G. Houtsma (SM), John C. Lane (A), Robert F. Wilson (M).

Syracuse Section

Harvey N. Roedl (J).

Texas Section

Roy L. Adams (M), Donald L. Derebey (J), Read Larson (J).

Twin City Section

Lee C. Paulson (J).

New Members Qualified

Continued

Washington Section

James J. Pugliese (J), Frederick T. Sadler (J).

Western Michigan Section

Robert Douglas Truckle (J).

Outside of Section Territory

Joseph Thomas Eichelberger (J), Frank A. Falkenthal (J), Cecil Jerrold Frankovitch (J), Charles J. Hager, Jr. (J), Gelston Howell (M), Walter Blake King, Jr. (M), Kenneth Kinnaird (A), Ferris P. Kneen (M), Stanley M. Madill (M), Thomas V. McNamara (J), Robert Sherman (J), Warren H. Smith (A), Kenneth P. Stapp (J), Redding A. Thompson, Jr. (J).

Foreign

Major U. S. Amin (FM), India; Sarup Singh Gill (FM), India; Guillermo Gomez (J), South America; Thomas Henry Innes (A), New Zealand.

Applications Received

The applications for membership received between Jan. 10, 1951, and Feb. 10, 1951 are listed below.

Baltimore Section

Joseph P. Bahorich.

British Columbia Section

Walter John Thiede.

Buffalo Section

Percy Hutton.

Canadian Section

T. J. Bell, Roy Robertson Borland, Stewart Brillinger, John Wilson Cook, Phil Gauvreau, James Douglas More Gray, William Hannah, Harford Hughes, Hugh Gordon Munro, Sydney Sylvester Payne, Lloyd Brian Walker.

Central Illinois Section

LeRoy S. Linn, Edgar W. Myers.

Chicago Section

Guveren M. Anderson, Willis M. Bercaw, Charles F. Bunker, Arthur C. Davis, Charles R. Flint, Ernest L. Gregory, Glenn C. Gridley, Jr., Harry

Continued on Page 117

Applications Received

Continued

B. Holthouse, Jr., Richard L. Hoover, Chansler G. Johnson, John Frank Kopczyk, Joseph C. Margetic, W. D. McMillan, George E. Mittelman, Arthur O. Radke, John J. Sichman, Jr., Burton K. Snyder, John Joachim Unger, Peter Wargo, Donald E. Wing.

Cincinnati Section
William H. Pruhs.

Cleveland Section
Elmer Milton Anderson, John Balint, Roger Glen Benjamin, Herbert P. Gusdane, Robert G. Hill, Worth Johnson, Holger Ridder, Theodore A. St. Clair, Herbert H. Schmiel, Jack Edward Schmitt, William L. Seitz.

Dayton Section
E. P. Hartman, Gerald E. Keinath, Clifford Marsh, Homer B. Nelson, Hugh Alexander Williams, Jr.

Detroit Section
John G. Alvenius, Thomas E. Arnold, Roy E. Batie, Harold E. Boettger, Don A. Cargill, Samuel Kelly Clark, Harry E. Davis, Merrill W. Dixon, Roy L. Ford, Ned Fuller, Jr., Wilson T. Groves, George J. Gaudaen, Drew C. Haneline, John R. Hull, Roy Hummel, Milanko Ikach, Surendra Kumar Jain, Clarence H. Jorgensen, Jr., J. Emmet Judge, Sheldon Kavieff, Alexander J. Lapointe, John R. Lees, Dale B. McCormick, Belding Henry McCurdy, George Henry Muller, Francis J. Newton, Allen K. Parrish, Richard A. Ramsay, L. S. Sanford, Howard B. Schweppe, Robert W. Smith, Arthur M. Sterren, Robert Harrison Stimpson, David V. Tinder, Richard W. Wantin, Chester M. Adams.

Hawaii Section
Chancellor J. Carter.

Indiana Section
W. Loing McCarthy.

Metropolitan Section
Edward J. Bowhay, Felix W. Braendel, Gerald Paul Clericuzio, Edward C. Fisher, Gaston Fleischel, Roy F. Hodson, Franklin W. Kolk, John A. C. Krulish, R. H. McGough, William J. Seigel.

Mid-Continent Section
Robert E. Weintraut.

Mid-Michigan Section
William D. Sherman.

Continued on Page 118

Applications Received

Continued

Milwaukee Section
Llywelyn Charles Evans, Loren D. Gilmore, Whitney Snyder.

Mohawk-Hudson Group
Edwin Nelson Morey.

Montreal Section
Guy L. Blain, Marcel Clark, Alan Stride.

New England Section
Frank H. Grinnel, Alfons Goedecke Taylor.

Oregon Section
Norman B. Chew, William H. Green.

Philadelphia Section
Robert George Kurtz, John K. Montgomery, Richard A. Sparker.

Pittsburgh Section
C. F. Sterbutzel.

Salt Lake Group
Reuben W. Ludtke.

Southern California Section
Robert W. Houston, Richard S. Palmer, Marshall Wood Paxton, Cameron W. Prentice, A. John Trainor.

Southern New England Section
William J. McCurdy.

Syracuse Section
Edward R. Brewer.

Texas Section
Sam R. Billingsley, Glenn L. Scherer.

Williamsport Group
Fred Muller, Jr.

Outside of Section Territory
Adolph Berg, Edward J. Bergin, Louis Alvin Campbell, J. Lowry Dobbs, Virgil Fiksdal, Wendell Howard Gray, Merlin Hansen, George Wesley Holmes, Graeme E. MacKinnon, Gordon Charles Mann, Frederick W. Scheel, Edwin B. Stueland, Roger Raymond Yoerger.

Foreign
Gustavo Aguirre, Argentina; Robert Boyazis, Belgium; Kyoichi Harashina, Japan; Faiyaz Ali Khan, England; Vaman Shrinivas Kudva, India; Stephen Silvester Lancefield, England; Marcel Reichel, France; Etsuro Sasamura, Japan; Frank W. Stokes, England; Gustav Adolph Wachsmuth, Brazil.

For the Sake of Argument

Get a Few Big Worries . . .

Norman G. Shidle

The most worried people you know are troubled about the smallest problems . . . but they are troubled about thousands of them. The least worried are those who face a few big ones.

And the difference between the two lies within each—not primarily in the problems which come to them. Given the same responsibilities, one will see each succeeding experience in relation to some single major objective . . . as a related part of one or two major problems. Mentally clear, he remains emotionally integrated—whatever the event. . . . The other drives through his days, stumbling from worry to worry, from crisis to crisis. . . . One is a statesman, the other a politician; one an executive, the other a boss; one a strength and stimulus to his associates, the other a prickly pear.

Few of us stop often enough to re-examine our objectives, to reset our sights. We get used to accepting as our aims the solving of the problems which each new day brings. Habit gets us to thinking of these semi-related, diffuse obligations as reasonable objectives in themselves.

But new patterns appear when we sit still and take thought. We begin to realize that we are harried because we lack overall objectives of our own, because we aren't fitting our scattered daily tasks into any permanent perspective.

Best integrated, of course, are those whose objectives are broad enough and selfless enough to encompass almost any situation. The man with straight money or power objectives will find a good many specific problems hard to harmonize. So, he will be emotionally stressed oftener than somebody who aims at the best service to his customers—or at harmony with his fellow man.

But whatever the aim, the man with an integrated objective doesn't face new problems all the time; just additional phases of known ones. Each daily task as it arises automatically falls into perspective—comfortably, neatly, harmoniously.

Most of us are strained more by trying to put ourselves in three different activities than by handling six in which we see a common objective. Making big ones out of little ones can pay dividends in strain reduction.

CONTROL THE *Friction Factor* DURING BREAK-IN

Parco Lubrite

prevents metal-to-metal contact
holds oil
reduces subsequent wear

Parco Lubrite is a chemical which produces a lubricant-holding coating on moving parts and bearing surfaces. The phosphate coating formed by Parco Lubrite prevents metal-to-metal contact, assists in a quick, more precise wearing-in and mating of the moving parts in the critical first few hours of operation.

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